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TIMBER

# RESOURCES of GALLATIN, PARK and MEAGHER COUNTIES

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RENEWABLE RESOURCES EVALUATION
INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION

REGION 1, USDA FOREST SERVICE

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# TIMBER RESOURCES
# of
# GALLATIN, PARK and MEAGHER COUNTIES

## DECEMBER, 1979

MONTANA DEPARTMENT OF
NATURAL RESOURCES AND CONSERVATION
FORESTRY DIVISION
2705 SPURGIN ROAD
MISSOULA, MONTANA 59801

and

RENEWABLE RESOURCES EVALUATION
INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
REGION 1, USDA FOREST SERVICE

# ABSTRACT

Inventory data collected for the 586 thousand acres of state and private commercial forest lands in Gallatin, Meagher, and Park counties indicates a total growing-stock volume of 930 million cubic feet. The most immediate problem for the forest is the high mortality rate. One third of the gross growth achieved is being lost by dying trees. Due to increased insect activity since the inventory was taken in 1976, the current mortality is expected to be substantially higher.

Based on inventory data, the indicated combined annual cut on state and private lands under the present level of management should range between 34 and 38 million board feet Scribner. The total harvest from state and private land since 1968 has averaged 35.9 million board feet Scribner.

Overall, the forest is in mediocre condition when compared to the ideal situation. Mature and overmature timber makes up the majority of the forest acres. Many stands have low board-foot volume per acre. Approximately 127,000 acres in the three counties are understocked and approximately 67,000 acres are overstocked. There are more 6- to 12-inch diameter trees than would be desired if the forest were regulated. Forest management activities, including regeneration efforts and stocking control, could increase timber production significantly; however, timber values would have to increase before it would be economical to implement intensive cultural practices. The most immediate means for gains in wood production are through further improved utilization, particularly in the salvage of dead material, and through commercial thinnings.

# CONTENTS

**Illustrations** . . . . . vi
**Tables** . . . . . vii
**Preface** . . . . . xi
**Abbreviations** . . . . . xiii
**Introduction** . . . . . 1
Geographical Overview
Forest Types
Other Forest Uses and Demands
Inventory Procedures
Data Reliability
**Major Inventory Findings** . . . . . 13
Area by Ownership Group
Ownership and Forest Land Acreage
Forest Type and Area
Productive Potential and Area
Timber Volume and Ownership
Growth, Mortality, and Ownership
Salvable Dead Volume
Per Acre Averages
**Analysis of the Timber Resource** . . . . . 25
Availability of the Timber
Potential Timber Output
Physical Characteristics of the Forest
**The Timber Situation by County** . . . . . 35
**Conclusions and Recommendations** . . . . . 41
Overview of Current Timber Resources
Past Harvest Rates and Allowable Cut Estimates
Can Production Be Increased
**Appendix 1. Additional Survey Information** . . . . . 45
**Appendix 2. Wood Processors in Working Circle 9** . . . . . 59
**Appendix 3. Field Data Forms** . . . . . 61
**Literature Cited** . . . . . 63
**Glossary** . . . . . 65

# ILLUSTRATIONS


| Figure | | Page |
|---|---|---|
| 1 | Geographical features of Working Circle 9. | 2 |
| 2 | Proportions of the total sampled area (forest and nonforest) by ownership group. | 13 |
| 3 | Net Scribner board-foot volume of sawtimber by species, Working Circle 9. | 18 |
| 4 | Net cubic feet of growing stock by species, Working Circle 9. | 19 |
| 5 | Net Scribner board-foot volume per acre by forest type. | 22 |
| 6 | Net cubic-foot volume per acre by forest type. | 23 |
| 7 | Potential softwood output curve for Working Circle 9. | 27 |
| 8 | Commercial forest land by stand size class, Working Circle. 9. | 31 |
| 9 | Actual and desired basal area per acre by diameter class for softwood forest types for productivity class 20-49, Working Circle 9. | 33 |
| 10 | Actual and desired basal area per acre by diameter class for softwood forest types for productivity class 50-84, Working Circle 9. | 33 |
| 11 | Proportions of commercial forest land by ownership group for each county. | 36 |
| 12 | Volume cut from state and private lands, calendar years 1968-1978, Working Circle 9 (in MMBF Scribner). | 42 |
| 13 | Forest situation in 1976 in relation to desired rotation, Working Circle 9. | 43 |
| 14 | Hypothetical situation after 40 years of management toward a regulated forest. | 43 |

| Map | | Page |
|---|---|---|
| 1 | Ownership | Inside Back Cover |
| 2 | Forest Cover | Inside Back Cover |

# TABLES


| Table | | Page |
|---|---|---|
| 1 | Forest-land area and associated sampling error percentages for Working Circle 9. | 8 |
| 2 | Net volume, net annual growth, and annual mortality on commercial forest land, with associated sampling error percentages for Working Circle 9. | 8 |
| 3 | Forest land area and associated sampling error percentages for Gallatin County. | 9 |
| 4 | Net volume, net annual growth, and annual mortality on commercial forest land, with associated sampling error percentages for Gallatin County. | 9 |
| 5 | Forest land area and associated sampling error percentages for Meagher County. | 10 |
| 6 | Net volume, net annual growth, and annual mortality on commercial forest land, and associated sampling error percentages for Meagher County. | 10 |
| 7 | Forest land area and associated sampling error percentages for Park County. | 11 |
| 8 | Net volume, net annual growth, and annual mortality on commercial forest land, with associated sampling error percentages for Park County. | 11 |
| 9 | Total land area by ownership, Working Circle 9. | 13 |
| 10 | Commercial and noncommercial forest land by ownership group, Working Circle 9 (in thousand acres). | 14 |
| 11 | Commercial forest land for softwoods and hardwoods by ownership group, Working Circle 9 (in thousand acres). | 14 |
| 12 | Commercial forest land by forest type, Working Circle 9 (in thousand acres). | 15 |
| 13 | Commercial forest land by forest type and ownership group, Working Circle 9 (in thousand acres). | 15 |
| 14 | Commercial forest land by M.A.I. site class for softwood and hardwood forest types by ownership group, Working Circle 9 (in thousand acres). | 16 |
| 15 | Average productivity by M.A.I. site class for softwood and hardwood forest types, Working Circle 9 (in $ft^3$/acre/year). | 16 |
| 16 | Net volume of growing stock for softwood and hardwood forest types by ownership group, Working Circle 9 (in thousand cubic feet). | 17 |
| 17 | Net board-foot volume of sawtimber for softwood and hardwood forest types by ownership group, Working Circle 9 (in MBF Scribner). | 17 |
| 18 | Net volume of sawtimber by species for commercial forest land by ownership group, Working Circle 9 (in MBF Scribner). | 18 |
| 19 | Net volume of growing stock by species for commercial forest land by ownership group, Working Circle 9 (in thousand cubic feet). | 19 |

| Table | | Page |
|---|---|---|
| 20 | Net cubic-foot growth of growing stock by softwood and hardwood forest type by ownership group, Working Circle 9 (in thousand cubic feet). | 20 |
| 21 | Net cubic-foot mortality of growing stock by softwood and hardwood forest type by ownership group, Working Circle 9 (in thousand cubic feet). | 20 |
| 22 | Net volume of salvable dead by condition of dead class, Working Circle 9 (in thousand cubic feet). | 21 |
| 23 | Area of commercial forest land by salvable dead volume class by county (in acres). | 21 |
| 24 | Availability class definitions and components. | 25 |
| 25 | Commercial forest land by class, availability class, and productivity class, Working Circle 9 (in acres). | 26 |
| 26 | Summary of indexes used to compare potential growth, current growth and mortality, softwood forest types only. | 28 |
| 27 | Average cubic-foot growth and mortality per acre by softwood and hardwood forest type by productivity class, Working Circle 9 (in $ft^3$/acre/year). | 29 |
| 28 | Net annual mortality of growing stock by species and M.A.I. site class, Working Circle 9 (in thousand cubic feet). | 29 |
| 29 | Annual mortality of growing stock on commercial forest land by cause of death (in cubic feet). | 30 |
| 30 | Net volume, annual gross growth, and mortality by diameter class for softwood species, Working Circle 9 (in thousand cubic feet). | 30 |
| 31 | Commercial forest land by stand age class, Working Circle 9 (in thousand acres). | 31 |
| 32 | Area of commercial forest land by stand size class and stocking percent class, Working Circle 9 (in acres). | 31 |
| 33 | Area of commercial forest land by stocking component and stocking percent class, Working Circle 9 (in acres). | 32 |
| 34 | Area of commercial forest land by softwood and hardwood forest type and area condition class, Working Circle 9 (in acres). | 32 |
| 35 | Area of commercial forest land by stand size class and insect and disease category, Working Circle 9 (in acres). | 34 |
| 36 | Total land area by ownership group by county (in acres). | 35 |
| 37 | Nonfederal land by ownership group by county (in thousand acres). | 36 |
| 38 | Commercial forest land for softwood and hardwood forest types by ownership group by county (in thousand acres). | 37 |
| 39 | Area of noncommercial forest land by softwood and hardwood forest types by county (in thousand acres). | 37 |

| Table | | Page |
|---|---|---|
| 40 | Area of commercial forest land by forest type by county (in thousand acres). | 37 |
| 41 | Commercial forest land by M.A.I. site class for softwood and hardwood forest types by county (in thousand acres). | 38 |
| 42 | Total net volume of growing stock for commercial softwood and hardwood types by county (in thousand cubic feet). | 38 |
| 43 | Total net volume of sawtimber for commercial softwood and hardwood types by county (in thousand board feet). | 38 |
| 44 | Net volume of sawtimber per acre for commercial softwood and hardwood types by county (in board feet per acre). | 39 |
| 45 | Net volume of growing stock per acre for commercial softwood and hardwood types by county (in cubic feet per acre). | 39 |
| 46 | Volume of growing stock on commercial forest land by species by county (in thousand cubic feet). | 39 |
| 47 | Volume of sawtimber on commercial forest land by species by county (in MBF Scribner). | 39 |
| 48 | Net growth by commercial softwood and hardwood forest types by county (in thousand cubic feet). | 40 |
| 49 | Net growth by commercial softwood and hardwood forest types by county (in MBF Scribner). | 40 |
| 50 | Net mortality by commercial softwood and hardwood forest types by county (in thousand cubic feet). | 40 |
| 51 | Net mortality by commercial softwood and hardwood forest types by county (in MBF Scribner). | 40 |
| 52 | Net growth per acre on commercial forest land by county. | 40 |
| 53 | Net mortality per acre on commercial forest land by county. | 40 |
| 54 | Volume cut from state and private lands, calendar years 1968-1978, Working Circle 9 (in board feet Scribner). | 42 |
| 55 | Data used to determine an annual cut using the stand analysis method. | 44 |
| 56 | Summary of the area of commercial forest land by forest type, stand size, and site class, 1976 (in acres). | 45 |
| 57 | Number of live and salvable dead trees by species and tree class. | 47 |
| 58 | Area of commercial forest land by net cubic-foot-per-acre stand-volume class. | 47 |
| 59 | Area of commercial forest land by net board-foot-per-acre stand-volume class. | 48 |
| 60 | Volume, growth, and mortality by M.A.I. site class (in cubic feet). | 48 |

| Table | | Page |
|---|---|---|
| 61 | Annual mortality of sawtimber by species and cause of death. | 49 |
| 62 | Net volume of nonsalvable dead by diameter class and condition of dead (in cubic feet). | 49 |
| 63 | Net volume of salvable dead by condition of dead class and diameter class (in cubic feet). | 50 |
| 64 | Estimated average age (at d.b.h.) by diameter class and M.A.I. class. | 50 |
| 65 | Area of commercial forest land by primary habitat type and local type (in acres). | 51 |
| 66 | Volume of growing stock by primary habitat type and species (in net cubic feet). | 52 |
| 67 | Net annual growth of growing stock by primary habitat type and species (in net cubic feet). | 53 |
| 68 | Habitat type group definitions for tables 65, 66, and 67. | 54 |
| 69 | Area of commercial forest land by local type and fuel model (in acres). | 55 |
| 70 | Basic management costs and expected yields for softwoods, Working Circle 9. | 56 |
| 71 | Ratio of net board-foot-Scribner volume to net cubic-foot volume by local type and diameter class. | 58 |
| 72 | Total area and available area of softwood forest land by availability class (in acres). | 58 |
| 73 | Wood-processing mills in Working Circle 9. | 59 |
| 74 | Key to table 73. | 60 |

# PREFACE

This publication summarizes the findings of a timber resource inventory that was conducted in Gallatin, Meagher, and Park counties (Working Circle 9), in the state of Montana. It is the first of a series of reports which will deal with the same type of timber inventory, but each report will be concerned with a different section of Montana. A final, statewide report will be published by the Intermountain Forest and Range Experiment Station, in cooperation with the Montana Department of Natural Resources and Conservation, Forestry Division.

The inventory project was started for Working Circle 9 in October of 1975 when representatives from the Intermountain Forest and Range Experiment Station, Region 1 of the USDA Forest Service, and DNRC signed a cooperative agreement to conduct a forest-resource study on all lands in Working Circle 9 other than those owned or administered by the USDA Forest Service or USDI Bureau of Land Management.

Sixty percent of the funding for the project was supplied by the USDA Forest Service, and the remaining 40 percent was provided by the state of Montana.

Preparing and planning for the project started in July of 1975 and continued into December of that year. Aerial photo interpretation and preparation for the field work was accomplished during the first six months of 1976, and the collection of data in the field followed from July to November.

This project could not have been completed without the willing assistance of numerous groups. DNRC, the Intermountain Forest and Range Experiment Station and Region 1, Division of State and Private Forestry jointly wish to acknowledge the following agencies, organizations and individuals for their contributions and cooperation:

Soil Conservation Service;

Agricultural Stabilization and Conservation Service;

Gallatin National Forest;

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Clerk and Recorder's offices in Gallatin, Meagher and Park counties;

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Montana Department of Fish, Wildlife and Parks;

Burlington Northern, Inc.;

USDI Bureau of Land Management;

Montana State University, Department of Plant and Soil Science;

Montana Woodland Council; and

local landowners who granted access to their lands.

For collecting the data, DNRC recognizes the forest inventory crew which included supervisor Brian Long, inventory foresters Jim Huter and Steve Wallace, inventory technicians Steve Jorgenson, Kurt Gelderman, Pete Metzmaker, Jeff Rupkalvis, Dave Remington and Bob Dillon, and secretary Sue Brown. DNRC also recognizes Don Howard for graphics, Patti McCarthy for typesetting, D. R. Breiby and Gary Wolf for layout, Larry Gill for photography and Mark Nicholson for editing, Earl Solmonson provided patient direction of the project.

# ABBREVIATIONS

| | |
|---|---|
| d.b.h. | diameter at breast height |
| DNRC | Montana Department of Natural Resources and Conservation |
| $ft^3$/acre/year | cubic feet per acre per year |
| M.A.I. | mean annual increment |
| MBF | thousand board feet |
| MMBF | million board feet |
| USDA | United States Department of Agriculture |
| USDI | United States Department of the Interior |

# INTRODUCTION

## GEOGRAPHICAL OVERVIEW

Working Circle 9, mapped in figure 1, is located in south central Montana. All or parts of eight mountain ranges are included in this working circle, which stretches north to the Little Belt Mountains in northern Meagher County and south to Yellowstone National Park south of Gallatin and Park counties. Elevations range from 4,000 feet along the Missouri River to 11,200 feet on Mount Cowan. Total land area for the three counties is 4.8 million acres, roughly equivalent to the size of New Jersey. The 57 percent of the land in Working Circle 9 that is privately owned or state owned was sampled in this study. This includes forest and agricultural land. The remaining 43 percent is administered by federal agencies. Of the land base sampled, about 22 percent is forested.

### Gallatin County

The heavily forested, mountainous terrain of the southern half of Gallatin County is broken only by the narrow canyon of the Gallatin River. Where it widens just south of Bozeman, the lower Gallatin Valley is an area of productive ranching and agricultural land which dominates the central portion of the county. The northern half of the county is marked by the Bridger Range on the east, with the drier juniper-dominated Horseshoe Hills stretching westward to the Missouri River.

Two-thirds of the county's 32,000 people live in Bozeman, which is the county seat and the location of Montana State University. Gallatin County has one sawmill which produces annually between 10,000 and 25,000 thousand board feet (MBF) and five others under 3,000 MBF annual production. (See table 73.) There are also seven post and pole processors. Approximately 23 percent of the 996,500 acres sampled in Gallatin County is commercial forest land.

### Park County

The Yellowstone Valley, the major drainage in Park County, lies between the Gallatin Range on the west and the Absaroka Mountains on the east. It is a wide, nontimbered valley heavily used for agriculture and recreation. North of Livingston, the Shields River drains an area from the east slopes of the Bridger Range to the crest of the Crazy Mountains.

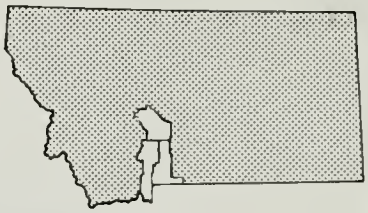
Slightly less than two-thirds of Park County's 11,000 citizens live in Livingston, the county seat. Two mills in Park County produce between 5,000 and 10,000 MBF annually, one produces between 3,000 and 5,000 MBF annually, and nine others produce under 3,000 MBF annually. Four post and pole processors operate in Park County. (See table 73.) Of Park County's 870,000 acres of private and state land, about 18 percent is commercial forest land.

### Meagher County

The majority of Meagher County lies in the Smith River Valley between the Little Belt and the Big Belt mountains. Further east, the county takes in all of the Castle Mountains and touches the northern portion of the Crazy Mountains. The mountains are generally more rounded and less steep than those in Park and Gallatin counties, and the forested zones are not as well defined. Many large parklike openings exist above 5,500 feet.

Although ranching is the predominant industry in the county, between 10,000 and 25,000 MBF are produced by mills in Meagher County and there are two post and pole processors. (See table 73.) Eighteen percent of the county's state and private land is commercial forest land. Of the three counties, Meagher County is the least populated, having 2,100 people. Its county seat and largest town is White Sulphur Springs.

# GEOGRAPHICAL FEATURES of WORKING CIRCLE 9



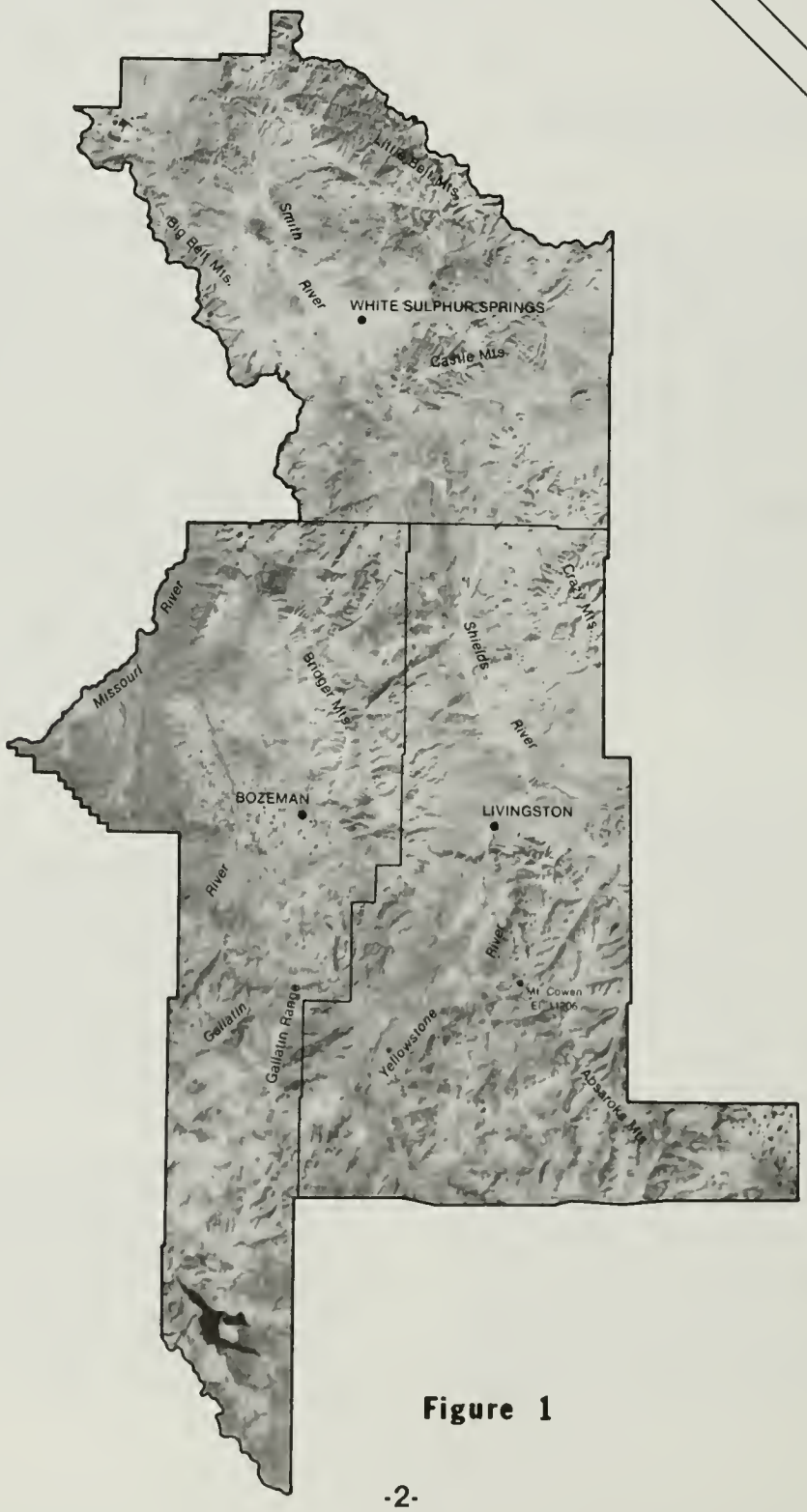



**Figure 1**

## FOREST TYPES

A description of each forest type as it occurs in Working Circle 9 follows. These descriptions may not be valid for other working circles in the state.

More than one tree species can occur within a given forest type. Forest type was determined for each field plot by the computer based on the species having the largest number of live trees. Individual trees were ranked according to their relative dominance on the plot. Those trees that were in excess of full stocking were dropped based on their dominance and did not count towards the forest type determination.

**Spruce type**

Most of the spruce trees found in Working Circle 9 are Englemann spruce (*Picea engelmanni*), but there are groups of white spruce (*Picea glauca*) and some Engelmann-white spruce hybrids. The spruce type is one of the most productive types but has a limited range. It is found on moderately moist and cool sites between Douglas fir and subalpine fir. It is usually limited to cool ravines beginning slightly below the lower limits of subalpine fir. Douglas fir and lodgepole pine are major seral components of this type. A long living species, spruce continues to grow beyond 200 years of age.

The spruce type comprises about 3 percent of the commercial forest land area. It is a commercial timber species, but often it is difficult to harvest due to its proximity to streams and areas with high water tables.

**Spruce-subalpine fir type**

The spruce-subalpine fir type occurs in cold and wet areas at 7,000 to 9,000 feet. Subalpine fir (*Abies lasiocarpa*) is more common in this type than spruce (*Picea* species). In fact, many stands are composed almost entirely of subalpine fir mixed with lodgepole pine and/or Douglas fir. There may only be an occasional spruce or none at all. Lodgepole pine and Douglas fir are seral components at lower elevations. At the upper elevational limit of this type, whitebark pine is a common associate. Subalpine fir is able to withstand drier and more exposed slopes than spruce.

Stands in this type tend to be unevenly aged. Highly tolerant subalpine fir will regenerate under heavy crown canopy, and will often grow very slowly until a break in competition allows increased height and diameter growth. Subalpine fir is also susceptible to fire, wind damage, and heart rot, and rarely lives past 250 years. Ten percent of the commercial forest is classified as the spruce-subalpine fir type.

**Ponderosa pine type**

Ponderosa pine type occurs only in Meagher County and is not extensive even in that area. Occupying the drier sites, ponderosa pine (*Pinus ponderosa*) is found in pure stands but more commonly in association with Douglas fir. Where found, the ponderosa pine type is the first forest type having timber importance encountered above nonforested valleys. About 3 percent of the commercial forest land is of the ponderosa pine type.

**Lodgepole pine type**

Lodgepole pine (*Pinus contorta*) is typically found in pure stands at elevations between 6,000 and 8,500 feet, and its occurrence is related to the fire history of the area. Prolific seeding capabilities and the serotinous nature of the cones usually lead to abundant regeneration following fire. This results in very dense stands which tend to stagnate. Lodgepole pine is a shade-intolerant species, but may grow in extremely dense stands for 80 to 100 years, consequently reducing the sawtimber growth possible under less competitive conditions.

Mountain pine beetle is currently of severe epidemic proportions, particularly in the area south of Bozeman. Lodgepole pine is the second most extensive type, covering 19 percent of the sampled commercial forest land area

**Douglas fir type**

Douglas fir (*Pseudotsuga menziesii* variety glauca) is the major timber producing species in Working Circle 9. Fifty-five percent of the commercial forest land sampled is occupied by the Douglas fir type. Douglas fir ranges in elevation from 5,000 feet to over 8,000 feet. In Park, and Gallatin counties, and in most of Meagher County, the lower elevations are usually pure Douglas fir. Between 6,000 and 8,000 feet in elevation, lodgepole pine is found as a seral species, and subalpine fir and spruce are potential climax species. Near its upper elevational limits, Douglas fir occurs on sunny, southward slopes or rocky ridges and not in the cooler areas occupied by the spruce-subalpine fir types. In drier, low elevation areas, it can be found mostly on the north- and east-facing slopes. Over much of the sampled area and especially in the Gallatin Canyon, much of the Douglas fir is infested by the spruce budworm.

**Whitebark-limber pine type**

Whitebark pine (*Pinus albicaulis*) and limber pine (*Pinus flexilis*) occupy the climatic extremes for trees in eastern Montana. Limber pine is found on some of the driest sites capable of supporting trees at both high and low elevations. Whether found in pure or mixed stands, timber productivity is low. The better part of the acreage attributed to the whitebark-limber pine forest type is comprised of whitebark pine. Found at the highest elevations where trees can grow, it is slow growing and long lived. Trees 400 to 500 years old are not uncommon. In this type, whitebark pine often grows in mixed stands with spruce and subalpine fir. The most exposed and dry timberline areas are predominately noncommercial stands of whitebark or limber pine. Approximately 4 percent of the commercial forest land area is in the whitebark-limber pine forest type. It is not an important commercial timber producing type.

**Cottonwood-aspen type** (left and below)

From a commercial forest standpoint, hardwood (for the most part *Populus* species) stands are of relatively minor importance in these counties and account for roughly 5 percent of the commercial forest land. Cottonwood is limited to the broad valleys of the major river systems where it occurs in pure stands.

Aspen stands are usually small and are intermingled with or adjacent to the conifer forest. Pure aspen stands are perpetuated by fire, but eventual succession by Douglas fir and spruce is common.

**Juniper type**

The juniper type is found in lower elevational areas, usually in the foothills between the non-forest and the forest zones. While Rocky Mountain juniper (*Juniperus scopalorum*) may occur in almost pure stands, these areas are classified noncommercial forest land. Where juniper is found with Douglas fir, ponderosa pine, or limber pine, a juniper forest type may have the potential to yield the minimum 20 cubic feet per acre per year ($ft^3$/acre/year) required to be inlcuded with the commercial forest land

## OTHER FOREST USES AND DEMANDS

### Woodland Grazing

Both state and private woodlands are used extensively by livestock for grazing. Under normal conditions, substantial forage is available under light to medium forest canopies and in scattered openings. Tree farming and ranching are not incompatable. Harvesting timber may increase forage production and subsequently grazing potential. Sound range management coupled with sound forestry yields a greater benefit from the forested lands.

### Wildlife

Some of the most significant big game herds in Montana are located in portions of the three county area. The Yellowstone Park elk herd, part of which migrates into the upper Gallatin and Yellowstone drainages, is of national significance. Smaller local populations are found in the Gallatin and Madison ranges, and the Absarokas, the Castle and Big Belt mountains within the working circle.

State and private lands provide a significant amount of the wildlife habitat. State and private lands generally occupy the lower mountain slopes and the cottonwood river bottoms. Much of the key winter range is on the private forest lands.

Winter range is commonly the limiting factor in big game habitat; however, it is no more important than the summer range. Logging can have favorable effects such as improving browse production. However, large scale removal of thermal cover in winter range areas or large scale removal of protective cover and increased public use created by construction of logging access roads in summer range areas can also have serious impacts on big game.

A wide variety of wildlife species are found in Working Circle 9. Some of the more significant species other than deer and elk include grizzly and black bear, moose, mountain goat, bighorn sheep, a variety of upland game birds and a variety of waterfowl.

### Fisheries

Portions of three major drainages and their tributaries are located in the sampled area. The upper Yellowstone, upper Missouri and the Gallatin rivers provide very good quality water. Streams like the Yellowstone and Gallatin and their tributaries are highly mineralized and are high in trout food production. Significant portions of these streams within the sampled area are within private ownership. Proper balances between the various forest land uses are necessary to protect and preserve the high quality fishery that exists on these streams.

### Outdoor Recreation

Many forms of forest recreation are pursued in the sampled area. Also, highway 191 through the Gallatin Canyon and highway 89 through the upper Yellowstone Valley are two scenic major access routes to Yellowstone Park. Maintenance of aesthetic quality within the visual area of these two routes will become more important.

Two other major forms of recreation in the area are hunting and fishing. A significant portion of the game animals and birds inhabit private lands or access to their habitats is through private lands.

Dispersed recreational activities are a significant use of the forested areas. This includes backpacking, cross-country skiing, mountain climbing, and recreational vehicle use, such as motor bikes, four-wheel drive vehicles, and snowmobiles.

### Water Resources

Water is one of the most valuable resources produced by Montana's forest lands, and watersheds are affected in many ways by timber management. The condition of the forests has decided effects on the quality, quantity and timing of water yield. Reducing stand densities will allow higher water yields, but the building of roads and the use of logging equipment disturbs soil cover and may result in soil loss and higher sedimentation loads in the streams. Thorough knowledge of the soils and the hydrology of a particular area must be secured to insure that implementation of a timber management plan for that area will not degrade water resources. Land use practices which benefit watersheds should be employed by forest landowners.

### Development

The commercial timber base has been shrinking in recent years due to the subdivision of manageable tracts of timber for recreational and conventional housing. Development on the forested lands in Working Circle 9 is not of major significance as compared to other areas in the state. More development has occurred in Gallatin County than the other two counties. Parcels of land in rural subdivisions are not likely to be considered by owners for timber production because aesthetics and nontimber values become more important. Subdivisions may also influence plans for timber management on adjacent land. In addition to the loss of timber, there is the loss of range for livestock and habitat for wildlife. This trend toward housing developments on forested lands will probably increase.

## INVENTORY PROCEDURES

This inventory was conducted using the stratified double sample technique which involves aerial photo interpretation and field sampling. Base data are collected on primary sample points at a density of one point per 100 acres. The primary sample points are located using a grid placed over USDI Geological Survey quadrangle maps. Primary sample points are transferred from the quadrangle maps to aerial photographs to be interpreted. The base data, or primary sample, are collected from the maps and photographs and include ownership, forest stand characteristics, and topographical characteristics. The primary sample points are then grouped into strata according to ownership group and forest characteristics. Field plots, each representing thirty-five to forty primary sample points, are randomly drawn from the strata proportional to the size of each stratum.

Each field plot is located on the ground in the same spot that the photo interpretation took place. Collection of field data is called the secondary sample. The field plot itself consists of ten sample points covering approximately one acre. At each point a variable radius plot tally and a fixed radius plot tally are made. The variable radius plot is for trees with a diameter at breast height of 5 inches and larger. A forty basal area factor limiting distance chart is used to determine which trees are tallied. The fixed radius plot is for trees under 5 inches diameter breast height (d.b.h.) and consisted of a circle one-three hundredth of an acre. Pfister's forest habitat types (Pfister et al. 1977) were recorded for each of the ten points. Appendix 3 contains copies of the record sheets used to collect data. The resulting data was edited and then tabulated by computer by the Intermountain Forest and Range Station using the FINSYS system. Board-foot volume is expressed in Scribner board feet unless otherwise noted.

## DATA RELIABILITY

The sampling errors presented in tables 1 through 8 are in terms of one standard error—the 67 percent confidence level. In other words, in two out of three times, the actual value will be within the specified confidence interval. Individual cells within tables should be used with caution. Some of the data presented in other tables are based on small sample sizes and as a result have high sampling errors. For example, the error for individual forest type acreages within the commercial forest land total will all have a higher error than 2.6 percent. (See table 1.)

**Table 1. Forest land area and associated sampling error percentages for Working Circle 9.**

| Item | Softwood Types | | Hardwood Types | | All Types | |
|---|---|---|---|---|---|---|
| | Acres | Error | Acres | Error | Acres | Error |
| Commercial forest land | 557,242 | ± 2.7%* | 29,055 | ±27.3% | 586,297 | ± 2.6% |
| Other forest land: | | | | | | |
| Unproductive reserved | 0 | 0 | 0 | 0 | 0 | 0 |
| Unproductive nonreserved | 44,823 | ±24.5 | 26,156 | ±34.3 | 70,979 | ±19.2 |

* To calculate the confidence interval, multiply 2.7 percent by 557,242 acres. In this example, the confidence interval would be 557,242 ± 15,046 acres.

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**Table 2. Net volume, net annual growth, and annual mortality on commercial forest land, with associated sampling error percentages for Working Circle 9.**

| Item | Softwoods | | Hardwoods | | All Species | |
|---|---|---|---|---|---|---|
| | Volume | Error | Volume | Error | Volume | Error |
| **Volume:** | | | | | | |
| Growing stock (thousand cubic feet) | 905,198 | ± 5.0% | 24,992 | ±26.6% | 930,190 | ± 4.9% |
| Sawtimber (MBF Scribner) | 2,507,113 | ± 6.0 | 33,817 | ±31.5 | 2,540,930 | ± 6.0 |
| **Net growth:** | | | | | | |
| Growing stock (thousand cubic feet) | 11,610 | ±1.2 | 560 | ±50.4 | 12,170 | ±10.9 |
| Sawtimber (MBF Scribner) | 54,032 | ±12.9 | 1,359 | ±84.8 | 55,391 | ±12.7 |
| **Mortality:** | | | | | | |
| Growing stock (thousand cubic feet) | 5,281 | ±17.1 | 401 | ±37.4 | 5,682 | ±16.2 |
| Sawtimber (MBF Scribner) | 14,729 | ±21.7 | 591 | ±72.5 | 15,320 | ±21.2 |

**Table 3. Forest land area and associated sampling error percentages for Gallatin County.**

| Item | Softwood Types | | Hardwood Types | | All Types | |
|---|---|---|---|---|---|---|
| | Acres | Error | Acres | Error | Acres | Error |
| Commercial forest land | 220,865 | ± 3.9% | 11,825 | ±45.0% | 232,690 | ± 3.7% |
| Noncommercial forest land | 10,227 | ±55.7 | 7,230 | ±59.6 | 17,457 | ±40.0 |

**Table 4. Net volume, net annual growth, and annual mortality on commercial forest land, with associated sampling error percentages for Gallatin County.**

| Item | Softwoods | | Hardwoods | | All Species | |
|---|---|---|---|---|---|---|
| | Volume | Error | Volume | Error | Volume | Error |
| **Volume:** | | | | | | |
| Growing stock (thousand cubic feet) | 351,975 | ± 8.3% | 10,419 | ± 41.4% | 362,394 | ± 8.2% |
| Sawtimber (MBF Scribner) | 1,025,544 | ± 9.9 | 15,780 | ± 46.7 | 1,041,324 | ± 9.9 |
| **Net growth:** | | | | | | |
| Growing stock (thousand cubic feet) | 4,388 | ±22.1 | 163 | ± 73.8 | 4,551 | ±21.4 |
| Sawtimber (MBF Scribner) | 19,839 | ±23.0 | 493 | ±100.0 | 20,332 | ±22.7 |
| **Mortality:** | | | | | | |
| Growing stock (thousand cubic feet) | 2,287 | ±27.5 | 144 | ± 66.2 | 2,431 | ±26.2 |
| Sawtimber (MBF Scribner) | 6,389 | ±35.6 | 292 | ±100.0 | 6,681 | ±34.6 |

**Table 5. Forest land area and associated sampling error percentages for Meagher County.**

| Item | Softwood Types | | Hardwood Types | | All Types | |
|---|---|---|---|---|---|---|
| | Acres | Error | Acres | Error | Acres | Error |
| Commercial forest land | 187,510 | ± 5.1% | 7,451 | ±58.5% | 194,961 | ± 5.0% |
| Noncommercial forest land | 19,968 | ±37.3 | 9,417 | ±53.8 | 29,385 | ±29.7 |

**Table 6. Net volume, net annual growth, and annual mortality on commercial forest land, with associated sampling error percentages for Meagher County.**

| Item | Softwoods | | Hardwoods | | All Species | |
|---|---|---|---|---|---|---|
| | Volume | Error | Volume | Error | Volume | Error |
| **Volume:** | | | | | | |
| Growing stock (thousand cubic feet) | 300,098 | ± 8.6% | 5,411 | ± 59.0% | 305,509 | ± 8.4% |
| Sawtimber (MBF Scribner) | 738,648 | ±10.5 | 2,429 | ± 82.0 | 741,077 | ±10.4 |
| **Net growth:** | | | | | | |
| Growing stock (thousand cubic feet) | 3,925 | ±12.2 | 244 | ± 97.0 | 4,169 | ±12.5 |
| Sawtimber (MBF Scribner) | 19,833 | ±20.1 | 362 | ±100.0 | 20,195 | ±19.9 |
| **Mortality:** | | | | | | |
| Growing stock (thousand cubic feet) | 1,576 | ±30.1 | 120 | ± 67.6 | 1,696 | ±28.3 |
| Sawtimber (MBF Scribner) | 4,239 | ±35.3 | 42 | ±100.0 | 4,281 | ±35.1 |

**Table 7. Forest land area and associated sampling error percentages for Park County.**

| Item | Softwood Types | | Hardwood Types | | All Types | |
|---|---|---|---|---|---|---|
| | Acres | Error | Acres | Error | Acres | Error |
| Commercial forest land | 148,866 | ± 5.7% | 9,779 | ±51.9% | 158,645 | ± 5.5% |
| Noncommercial forest land | 14,629 | ±44.0 | 9,508 | ±62.0 | 24,137 | ±33.6 |

**Table 8. Net volume, net annual growth, and annual mortality on commercial forest land, with associated sampling error percentages for Park County.**

| Item | Softwoods | | Hardwoods | | All Species | |
|---|---|---|---|---|---|---|
| | Volume | Error | Volume | Error | Volume | Error |
| **Volume:** | | | | | | |
| Growing stock (thousand cubic feet) | 253,125 | ±10.8% | 9,161 | ± 52.1% | 262,286 | ±10.6% |
| Sawtimber (MBF Scribner) | 745,758 | ±12.6 | 12,772 | ± 59.6 | 758,530 | ±12.5 |
| **Net growth:** | | | | | | |
| Growing stock (thousand cubic feet) | 3,298 | ±25.7 | 153 | ± 87.5 | 3,451 | ±24.8 |
| Sawtimber (MBF Scribner) | 14,360 | ±28.9 | 504 | ±100.0 | 14,864 | ±28.4 |
| **Mortality:** | | | | | | |
| Growing stock (thousand cubic feet) | 1,418 | ±37.8 | 136 | ± 71.5 | 1,554 | ±35.1 |
| Sawtimber (MBF Scribner) | 4,100 | ±48.3 | 257 | ±100.0 | 4,357 | ±46.3 |

# MAJOR INVENTORY FINDINGS

## AREA BY OWNERSHIP GROUP

Table 9 tabulates the amount of land in each ownership group.

The private ownership groups cover 57 percent of the land area. The remaining 43 percent of the land area is owned or administered by public agencies. The USDA Forest Service administers the largest amount of public land which includes the largest block of forest land acreage.

This project inventoried only the state, county, municipal, and private ownership groups. The proportion of this land held by each of these ownership groups is illustrated in figure 2. The total sampled area in this survey was approximately 2.9 million acres and included forested and nonforested land.

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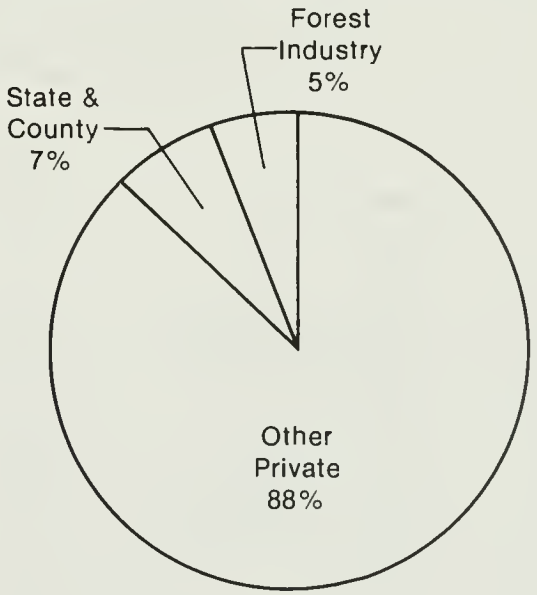
**Table 9. Total land area by ownership group, Working Circle 9.**

| Ownership Group | Acreage | Percentage of Total |
|---|---|---|
| **Public:** | | |
| Bureau of Land Management | 38,777 | 1 |
| USDA Forest Service | 1,840,447 | 38 |
| State | 202,807 | 4 |
| County and municipal | 5,354 | * |
| Subtotal | 2,087,385 | 43 |
| **Private:** | | |
| Forest industry | 149,909 | 3 |
| Other private | 2,565,236 | 54 |
| Subtotal | 2,715,145 | 57 |
| **TOTAL** | **4,802,530** | **100** |

* Less than 0.5 percent

**Figure 2. Proportion of the total sampled area (forest and nonforest) by ownership group.**



Of the forest land surveyed, 74.2 percent—441,000 acres—is owned by private interests other than forest industry. Within these private interests, farmer-ranchers own 412,800 acres, other private corporations (corporations outside the forest industry) own 17,200 acres, and other private individuals (individuals owning pieces of land smaller than 40 acres) own 11,000 acres. The amount and percentage of surveyed forest land held by each ownership group are tabulated in tables 10 and 11.

Although the forest industry owns only 5 percent of the sampled area (see figure 2), the forest industry owns 19.6 percent of the commercial forest land area (see table 11). The forest industry and farmer-rancher together own 90 percent of the sampled commercial forest land in Working Circle 9.

**Table 10. Commercial and noncommercial forest land by ownership group, Working Circle 9 (in thousand acres).**

| Ownership Group | Commercial Forest Land | Noncommercial Forest Land | All Forest Land | Percentage of Total |
|---|---|---|---|---|
| **Public:** | | | | |
| State | 27.1 | 3.8 | 30.9 | 4.7% |
| County and municipal | 3.4 | 0.3 | 3.7 | 0.6 |
| Subtotal | 30.5 | 4.1 | 34.6 | 5.3 |
| **Private:** | | | | |
| Forest industry | 114.8 | 7.8 | 122.6 | 18.7 |
| Farmer-rancher | 412.8 | 56.1 | 468.9 | 71.3 |
| Other private corporate | 17.2 | 2.1 | 19.3 | 2.9 |
| Other private individual | 11.0 | 0.9 | 11.9 | 1.8 |
| Subtotal | 555.8 | 66.9 | 622.7 | 94.7 |
| **TOTAL** | **586.3** | **71.0** | **657.3** | **100.0** |

**Table 11. Commercial forest land for softwoods and hardwoods by ownership group, Working Circle 9 (in thousand acres).**

| Ownership Group | Softwood Types | Hardwood Types | Total Commercial Forest Land | Percentage of Total |
|---|---|---|---|---|
| **Public:** | | | | |
| State | 25.0 | 2.1 | 27.1 | 4.6% |
| County and municipal | 3.4 | * | 3.4 | 0.6 |
| Subtotal | 28.4 | 2.1 | 30.5 | 5.2 |
| **Private:** | | | | |
| Forest industry | 112.7 | 2.1 | 114.8 | 19.6 |
| Farmer-rancher | 392.5 | 20.3 | 412.8 | 70.4 |
| Other private-corporate | 16.9 | 0.3 | 17.2 | 2.9 |
| Other private-individual | 6.8 | 4.2 | 11.0 | 1.9 |
| Subtotal | 528.9 | 26.9 | 555.8 | 94.8 |
| **TOTAL** | **557.3** | **29.0** | **586.3** | **100.0** |

* Less than 50 acres

## FOREST TYPE AND AREA

About 80 percent of the commercial forest land acreage is covered by the four most important commercial forest types: Douglas fir, lodgepole pine, ponderosa pine, and spruce. Twenty-nine thousand acres are in the hardwood forest types. The aspen portion is found scattered among the softwood forest land in small patches or clumps. Cottonwood is found growing mainly along rivers and stream bottoms in the foothills and valleys. The area and the percentage of surveyed commercial forest land in each forest type are shown in table 12. Table 13 shows how much land in each forest type is held by each ownership group.

**Table 12. Commercial forest land by forest type, Working Circle 9 (in thousand acres).**

| Forest Type | Area | Percentage of Total |
|---|---|---|
| Douglas fir | 325.0 | 55.4% |
| Lodgepole pine | 113.2 | 19.3 |
| Spruce-subalpine fir | 56.3 | 9.6 |
| Whitebark-limber pine | 25.7 | 4.4 |
| Ponderosa pine | 14.9 | 2.5 |
| Spruce | 14.9 | 2.5 |
| Juniper | 7.3 | 1.3 |
| Aspen | 22.0 | 3.8 |
| Cottonwood | 7.0 | 1.2 |
| **TOTAL** | **586.3** | **100.0** |

**Table 13. Commercial forest land by forest type and ownership group, Working Circle 9 (in thousand acres).**

| | OWNERSHIP GROUP | | | |
|---|---|---|---|---|
| Forest Type | State | Forest Industry | Other Private | Total |
| Douglas fir | 14.6 | 55.9 | 252.6 | 323.1 |
| Lodgepole pine | 5.3 | 29.4 | 77.7 | 112.4 |
| Spruce-subalpine fir | 2.4 | 14.3 | 39.1 | 55.8 |
| Whitebark-limber pine | 1.4 | 7.4 | 16.7 | 25.5 |
| Ponderosa pine | 0.6 | * | 14.3 | 14.9 |
| Spruce | 0.5 | 4.6 | 9.6 | 14.7 |
| Juniper | 0.2 | 1.1 | 6.0 | 7.3 |
| Aspen | 1.6 | 2.1 | 18.4 | 22.1 |
| Cottonwood | 0.5 | * | 6.5 | 7.0 |
| **TOTAL**** | **27.1** | **114.8** | **440.9** | **582.8** |

* Less than 50 acres.
** Acreage totals exclude county and municipal acreage.

## PRODUCTIVE POTENTIAL AND AREA

Mean annual increment (M.A.I.) site class is a term used to describe the potential of the forest to produce wood. It is expressed as the number of cubic feet of wood per acre per year produced by fully stocked natural stands up to the year of culmination of the M.A.I. The year that the M.A.I. curve peaks is the culmination of the longest period which can be allowed for a rotation based on maximum cubic-foot production. A longer period results in a progressive decrease in the annual increment and lowers the entire average growth.

The potential productivity for a given field plot is based on site tree measurements taken on the plot. Due to the condition of many forest stands in the sample area, it is often difficult to find suitable site trees. This results in estimates of potential productivity that are adequate but conservative for many field plots. Average site index for a plot is used to predict cubic-foot production based on yield equations for fully stocked natural stands. The predicted yield is reduced appropriately when it is evident that the entire acre could not support trees. The amount of area covered by each site class if given by ownership group in table 14.

Table 14. Commercial forest land by M.A.I. site class for softwood and hardwood forest types by ownership group, Working Circle 9 (in thousand acres).

| | Softwood Forest Types | | | Hardwood Forest Types | | | Total All Forest Types | | |
|---|---|---|---|---|---|---|---|---|---|
| | Site Class | | | Site Class | | | Site Class | | |
| Ownership Group | 20-49 | 50-84 | Total | 20-49 | 50-84 | Total | 20-49 | 50-84 | Total |
| State, county and municipal | 22.8 | 5.6 | 28.4 | 1.6 | 0.6 | 2.2 | 24.4 | 6.2 | 30.6 |
| Forest industry | 85.7 | 27.0 | 112.7 | 1.0 | 1.0 | 2.0 | 86.7 | 28.0 | 114.7 |
| Other private | 355.1 | 61.0 | 416.1 | 18.8 | 6.1 | 24.9 | 373.9 | 67.1 | 441.0 |
| **TOTAL** | **463.6** | **93.6** | **557.2** | **21.4** | **7.7** | **29.1** | **485.0** | **101.3** | **586.3** |

The overall average potential production for softwood forest types is 39 ft³/acre/year. The overall average potential production for hardwood forest types was 38 ft³/acre/year.* Table 15 shows the average productivity for softwoods and hardwoods by M.A.I. site class.

* See the glossary for more explanation of potential growth and net annual growth.

Table 15. Average productivity by M.A.I. site class for softwood and hardwood forest types, Working Circle 9 (in ft³/acre/year).

| | Average Potential Production | | |
|---|---|---|---|
| | Site Class | | |
| Forest Type | 20-49 | 50-84 | Overall Average |
| Softwoods | 35 | 56 | 39 |
| Hardwoods | 33 | 53 | 38 |

## TIMBER VOLUME AND OWNERSHIP

### Volume By Forest Type

In Working Circle 9, timber volume is comparable to area, regardless of ownership group. For example, forest industry has about 20 percent of the commercial forest land and approximately 22 percent of the volume. The same situation exists with the other ownership groups. Table 16 is an analysis of the net volume of growing stock by forest type, and table 17 provides similar information in terms of board feet.

The softwood volume found in the hardwood forest types is usually growing with aspen. Cottonwood stands typically are pure stands.

**Table 16. Net volume of growing stock for softwood and hardwood forest types by ownership group, Working Circle 9 (in thousand cubic feet).**

| Ownership Group | Softwood Forest Types | | Hardwood Forest Types | | |
|---|---|---|---|---|---|
| | Softwood Volume | Hardwood Volume | Softwood Volume | Hardwood Volume | Total Volume |
| **Public:** | | | | | |
| State | 41,826.5 | 282.9 | 272.9 | 1,428.7 | 43,811.0 |
| County and municipal | 6,057.1 | 32.8 | 6.0 | 3.4 | 6,099.3 |
| Subtotal | 47,883.6 | 315.7 | 278.9 | 1,432.1 | 49,910.3 |
| **Private:** | | | | | |
| Forest industry | 198,561.7 | 829.4 | 316.0 | 260.4 | 199,967.5 |
| Farmer-rancher | 618,271.1 | 4,279.4 | 1,299.6 | 16,326.4 | 640,176.5 |
| Other private corporate | 26,407.1 | 23.0 | 118.6 | 240.3 | 26,789.0 |
| Other private industry | 10,210.9 | 1,935.9 | 115.1 | 1,084.3 | 13,346.2 |
| Subtotal | 853,450.8 | 7,067.7 | 1,849.3 | 17,911.4 | 880,279.2 |
| **TOTAL** | **901,334.4** | **7,383.4** | **2,128.2** | **19,343.5** | **930,189.5** |

**Table 17. Net board-foot volume of sawtimber for softwood and hardwood forest types by ownership group, Working Circle 9 (in MBF Scribner).**

| Ownership Group | Softwood Forest Types | | Hardwood Forest Types | | |
|---|---|---|---|---|---|
| | Softwood Volume | Hardwood Volume | Softwood Volume | Hardwood Volume | Total Volume |
| **Public:** | | | | | |
| State | 117,271.1 | 616.2 | 1,235.9 | 1,570.3 | 120,693.5 |
| County and municipal | 18,126.3 | 106.9 | 27.7 | 9.0 | 18,269.9 |
| Subtotal | 135,397.4 | 723.1 | 1,263.6 | 1,579.3 | 138,963.4 |
| **Private:** | | | | | |
| Forest industry | 565,676.2 | 2,422.0 | 1,437.4 | 642.3 | 570,177.9 |
| Farmer-rancher | 1,689,709.2 | 8,864.4 | 4,751.5 | 18,161.1 | 1,721,486.2 |
| Other private corporate | 68,756.5 | 160.1 | 87.7 | 272.5 | 69,276.8 |
| Other private industry | 30,707.0 | 249.4 | 9,326.6 | 743.1 | 41,026.1 |
| Subtotal | 2,354,848.9 | 11,695.9 | 15,603.2 | 19,819.0 | 2,401,967.0 |
| **TOTAL** | **2,490,246.3** | **12,419.0** | **16,866.8** | **21,398.3** | **2,540,930.4** |

### Volume By Species

Douglas fir and lodgepole pine comprised the majority of the board-foot and cubic-foot volume. Together they accounted for 74 percent of both the total cubic-foot volume and the total board-foot volume.

Figure 3 illustrates the board-foot volume of sawtimber for each species. Table 18 analyzes the board-foot volume of sawtimber for each species in each ownership group. Figure 4 illustrates the cubic-foot volume of growing stock for each species. Table 19 analyzes the net volume of growing stock for each species in each ownership group.

**Figure 3. Net Scribner board-foot volume of sawtimber by species, Working Circle 9.**

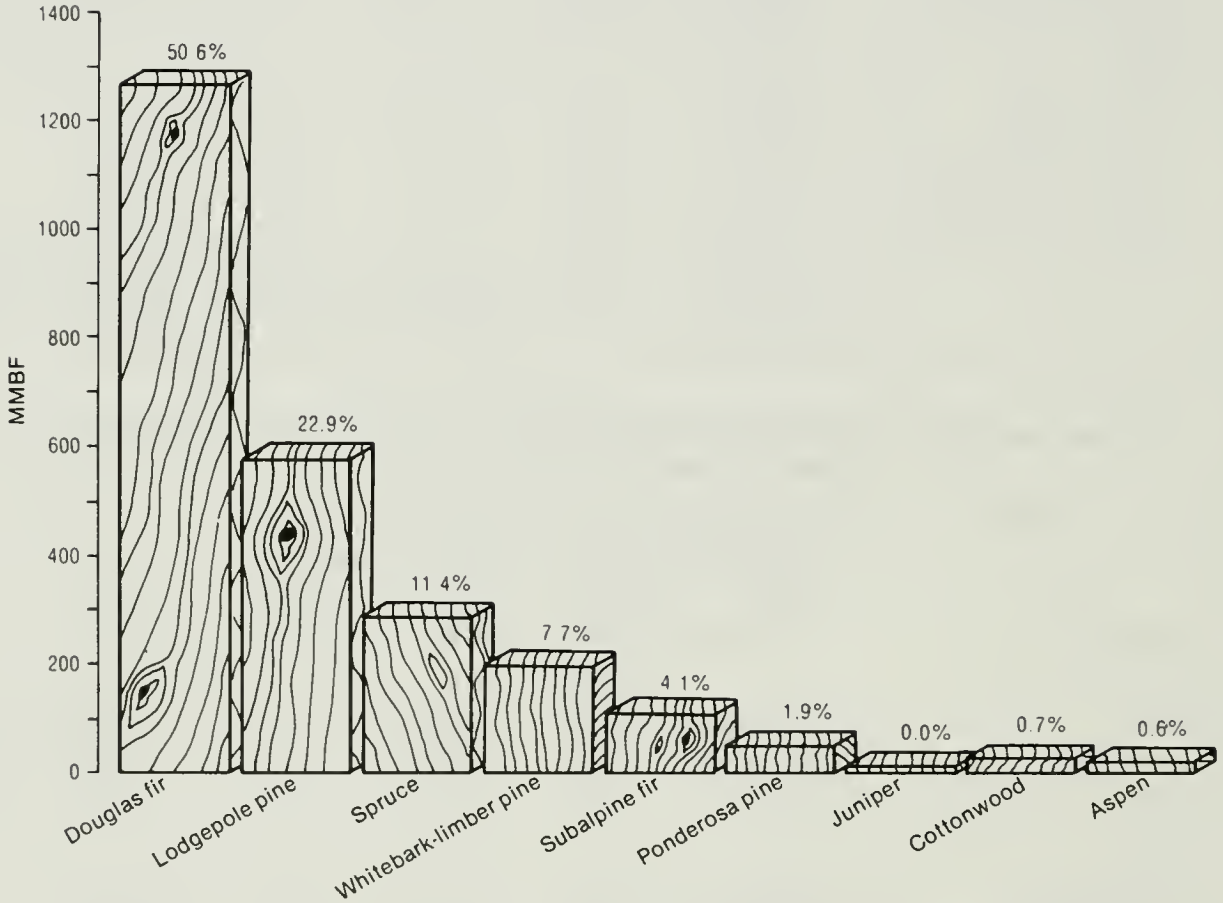



**Table 18. Net volume of sawtimber by species for commercial forest land by ownership group, Working Circle 9 (in MBF Scribner).**

| Ownership Group | Douglas Fir | Ponderosa Pine | Lodgepole Pine | Whitebark-Limber Pine | Subalpine Fir | Spruce | Juniper | Aspen | Cottonwood | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| State, county and municipal | 68,454.0 | 1,551.7 | 32,342.7 | 11,509.9 | 6,004 4 | 16,780.1 | 18.3 | 997.4 | 1,305.1 | 138,963 6 |
| Forest industry | 241,985.9 | 82.9 | 144,154.5 | 63,699.8 | 29,643.6 | 87,381.3 | 165.5 | 1,501.4 | 1,563.0 | 570,177.9 |
| Farmer-rancher | 910,602.7 | 42,666.7 | 383,561.0 | 114,960.8 | 65,337.9 | 176,324.4 | 1,007.3 | 12,046.0 | 14,979.5 | 1,721,486.3 |
| Other private-corporate | 37,191.0 | 2,889.7 | 16,597.0 | 3,369.6 | 2,498.2 | 6,298 1 | 0.4 | 185.6 | 247.0 | 69,276.6 |
| Other private-individual | 27,123.7 | 308 5 | 5,481.9 | 2,848 2 | 1,044 1 | 3,226.2 | 0.9 | 429.8 | 562.7 | 41,026.0 |
| TOTAL | 1,285,357.3 | 47,499.5 | 582,137.1 | 196,388.3 | 104,528.2 | 290,010.1 | 1,192.4 | 15,160.2 | 18,657.3 | 2,540,930.4 |

**Figure 4. Net cubic feet of growing stock by species, Working Circle 9.**

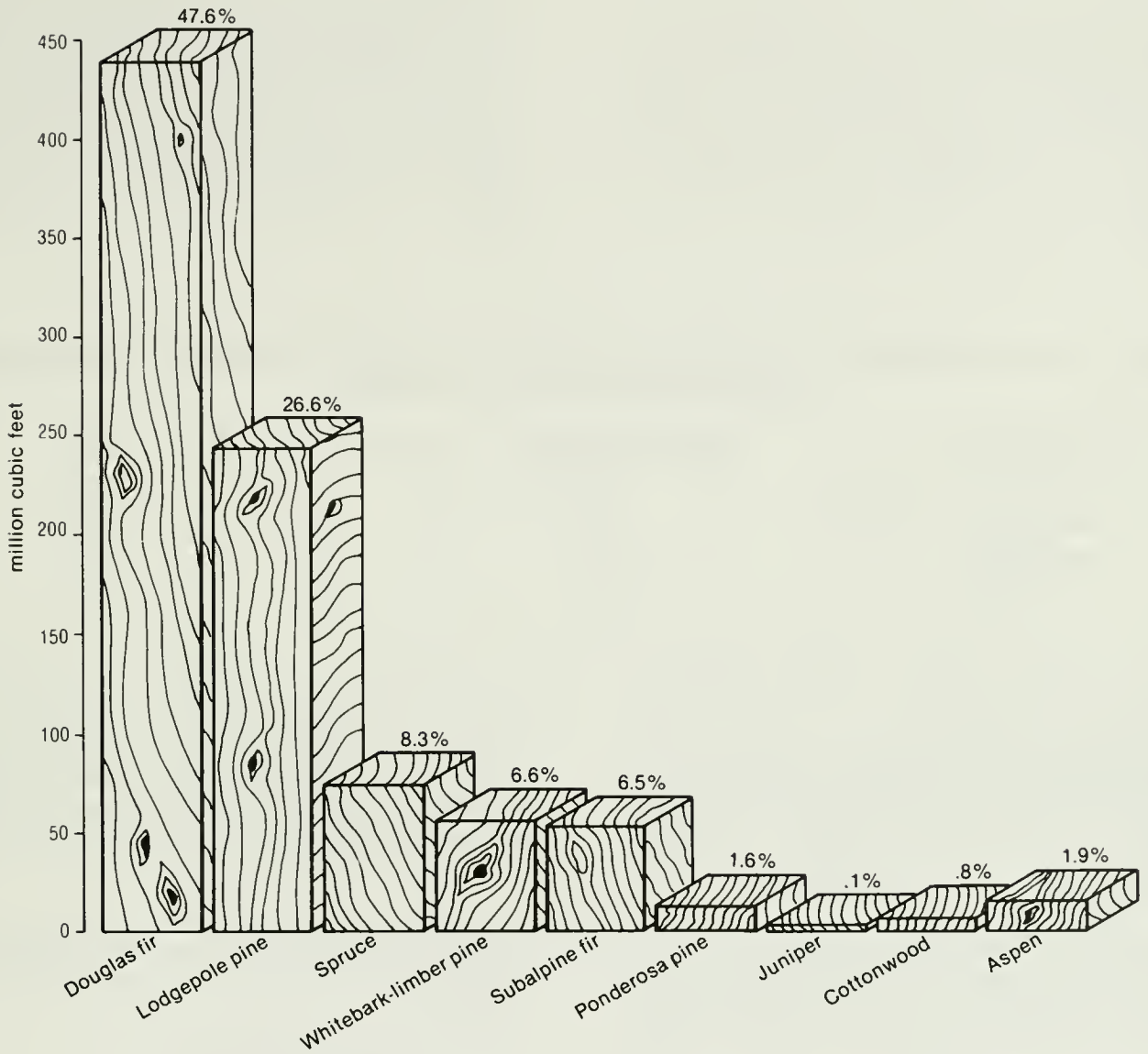



**Table 19. Net volume of growing stock by species for commercial forest land by ownership group, Working Circle 9 (in thousand cubic feet).**

| Ownership Group | Douglas Fir | Ponderosa Pine | Lodgepole Pine | Whitebark-Limber Pine | Subalpine Fir | Spruce | Juniper | Aspen | Cottonwood | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| State, county and municipal | 22,943.6 | 503.8 | 13,260.1 | 3,580.0 | 3,377.1 | 4,485.6 | 22.1 | 1,197.8 | 540.0 | 49,910.1 |
| Forest industry | 81,027.9 | 24.0 | 57,714.6 | 19,328.8 | 16,974.5 | 23,655.3 | 152.6 | 704.4 | 385.4 | 199,967.5 |
| Farmer-rancher | 317,542.4 | 13,715.2 | 166,334.9 | 36,133.5 | 38,317.6 | 46,801.2 | 726.1 | 14,341.5 | 6,264.3 | 640,176.7 |
| Other private-corporate | 13,566.1 | 904.3 | 7,613.0 | 1,132.6 | 1,542.7 | 1,667.1 | 4.3 | 260.8 | 98.1 | 26,789.0 |
| Other private-individual | 7,488.8 | 89.9 | 2,171.6 | 846.2 | 648.3 | 898.3 | 3.3 | 947.4 | 252.0 | 13,345.8 |
| **TOTAL** | **442,568.8** | **15,237.2** | **247,094.2** | **61,021.1** | **60,860.2** | **77,507.5** | **908.4** | **17,451.9** | **7,539.8** | **930,189.1** |

## GROWTH, MORTALITY, AND OWNERSHIP

The farmer-rancher and other private ownership groups are producing about 75 percent of the total net cubic-foot growth. Forest industry land is producing 20 percent. Net growth, shown in table 20, is the result of subtracting mortality from gross growth. The total softwood gross growth is 17.1 million cubic feet per year while mortality is 5.4 million cubic feet or roughly one-third of the gross growth.

Growth and mortality are dynamic values that can vary from year to year. Gross growth can be affected by many factors. One man-caused factor influencing growth is logging. Logging can convert mature and overmature stands in an orderly manner to healthier, faster growing young stands. But, if the proper care is not taken to get quick regeneration and to control stocking, or if the forest is overcut so that the growing stock is reduced below optimum levels, the sustainable net annual yields may be significantly reduced.

**Table 20. Net cubic-foot growth of growing stock by softwood and hardwood forest type by ownership group, Working Circle 9 (in thousand cubic feet).**

| Ownership Group | Softwood Forest Types | Hardwood Forest Types | Total |
|---|---|---|---|
| State, county and municipal | 603.2 | 37.7 | 640.9 |
| Forest industry | 2,336.8 | 9.8 | 2,346.6 |
| Other private | 8,721.9 | 461.3 | 9,183.2 |
| **TOTAL** | **11,661.9** | **508.8** | **12,170.7** |

The effects of the mountain pine beetle and the spruce budworm combined have a significant impact on growth. Spruce budworm reduces growth by defoliating portions or all of the crown. Unless the infestation is severe for several years, it usually does not kill the tree. Table 21 analyzes mortality by ownership group.

Mortality is the volume of trees dying due to natural causes each year. Trees removed by logging are not considered as mortality trees. Insects, disease, fire and weather are the main natural contributors. The mortality estimates in this report are based on measurements made in 1976. Since that year, the mountain pine beetle epidemic has increased. More trees have been killed since 1976 and because of this the mortality estimates in this report will be lower than the current rate of loss.

Seventy-one percent of the volume lost to mortality was attributed to the other private ownership group. Forest industry had about 23 percent of the volume loss.

**Table 21. Net cubic-foot mortality of growing stock by softwood and hardwood forest type by ownership group, Working Circle 9 (in thousand cubic feet).**

| Ownership Group | Softwood Forest Types | Hardwood Forest Types | Total |
|---|---|---|---|
| State, county and municipal | 307.3 | 18.1 | 325.4 |
| Forest industry | 1,314.7 | 1.0 | 1,315.7 |
| Other private | 3,817.4 | 223.9 | 4,041.3 |
| **TOTAL** | **5,439.4** | **243.0** | **5,682.4** |

## SALVABLE DEAD VOLUME

Almost 74 million cubic feet of salvable dead material are scattered about the state and private forests. (See table 22.) The sawtimber component of the salvable dead material is 170.9 million board feet (computed using tables 63 and 71), which is equivalent to five times the average volume harvested each year in the three counties combined. (See table 54.)

Table 23 shows the distribution of the salvable dead material by displaying acres of commercial forest land by volume class of salvable dead. Seventy-one percent of the commercial forest land has less than 100 cubic feet of salvable dead material per acre. About 2 percent of the commercial forest land—11,270 acres—has over 1,000 cubic feet per acre of salvable dead material.

**Table 22. Net volume of salvable dead by condition of dead class, Working Circle 9 (in thousand cubic feet).**

| CONDITION CLASS | | | | | | |
|---|---|---|---|---|---|---|
| No Defect | | Defect—Mostly Physical | | Defect—Mostly Rot | | Total |
| Standing | Down | Standing | Down | Standing | Down | |
| 4,397.3 | 762.4 | 25,477.4 | 7,335.0 | 24,080.4 | 11,697.4 | 73,749.9 |

Salvable dead material, after a short period of time, becomes unuseable for many products. The figures shown are reliable only for the time of measurement. The estimates may be useful to indicate trends or potential material available to industries for various product uses, but much of the estimated volume is scattered and would be economically inoperable or inaccessable for salvage operation.

The amount of salvable dead material is expected to increase proportionately to the increased mountain pine beetle activity.

**Table 23. Area of commercial forest land by salvable dead volume class by county (in acres).**

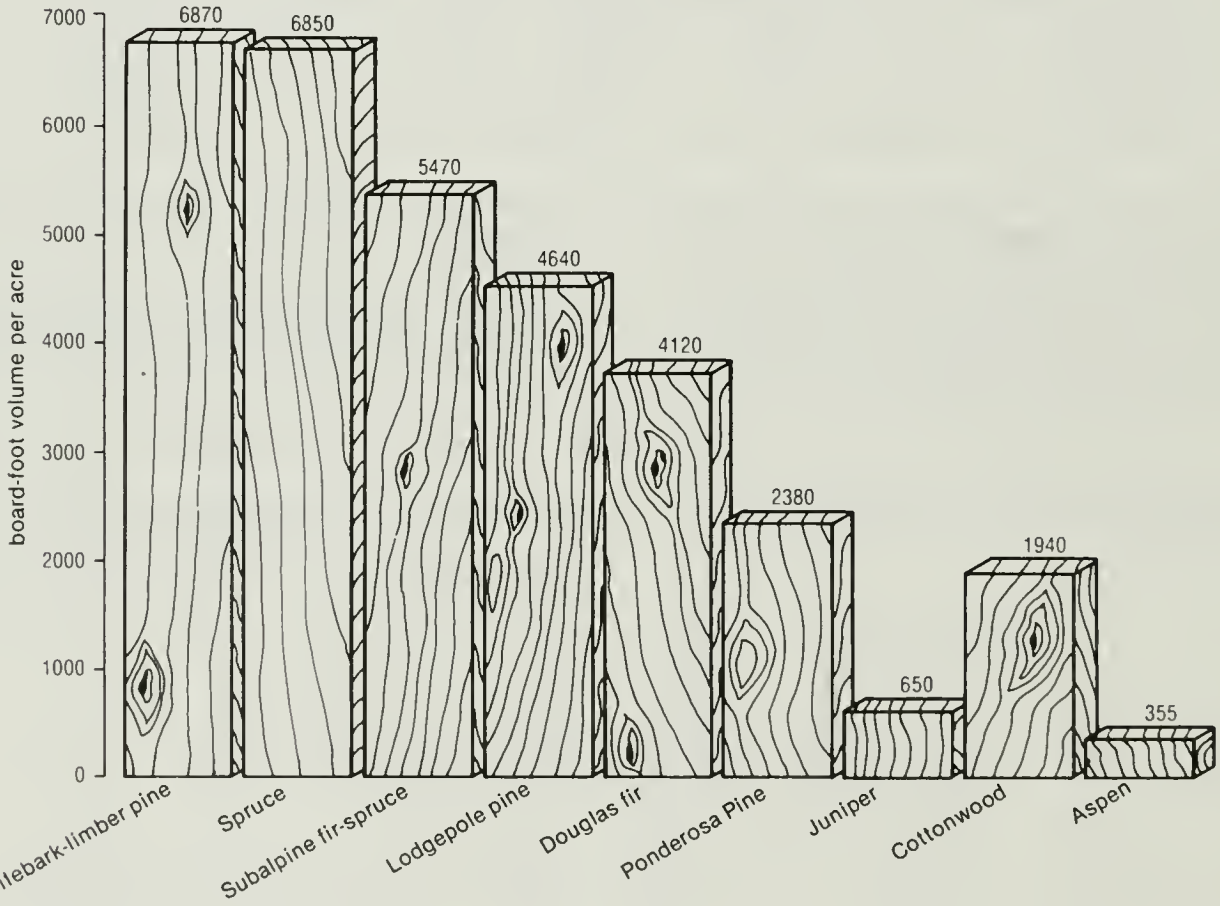
| Volume Class (Net cubic feet per acre) | ACRES BY COUNTY | | | |
|---|---|---|---|---|
| | Gallatin | Meagher | Park | Total |
| None | 101,072 | 85,631 | 66,607 | 253,310 |
| 1 - 100 | 63,615 | 55,855 | 45,252 | 164,722 |
| 101 - 200 | 26,835 | 24,163 | 20,278 | 71,276 |
| 201 - 300 | 12,928 | 4,121 | 9,232 | 26,281 |
| 301 - 400 | 8,472 | 4,815 | 5,316 | 18,603 |
| 401 - 500 | 1,937 | 11,176 | 1,626 | 14,739 |
| 501 - 600 | 5,014 | 3,498 | 2,392 | 10,904 |
| 601 - 700 | 3,711 | 0 | 3,613 | 7,324 |
| 701 - 800 | 2,603 | 0 | 1,141 | 3,744 |
| 801 - 900 | 0 | 4,121 | 0 | 4,121 |
| 901 - 1000 | 0 | 0 | 0 | 0 |
| 1001 - 1500 | 3,863 | 1,029 | 2,507 | 7,399 |
| 1500 + | 2,641 | 550 | 680 | 3,871 |
| **TOTAL** | **232,691** | **194,959** | **158,644** | **586,294** |

## PER-ACRE AVERAGES

### Volume Per Acre By Forest Type

Whitebark-limber pine and spruce types had the highest average board-foot volume per acre. (See figure 5.) There are two principle reasons for whitebark-limber pine's high volume per acre average. First, there was very little pole-sized or seedling-sapling stands in the whitebark pine type to bring the average down. Secondly, for most of the forest acreage in this type, the stands were well stocked. In many of these stands, whitebark pine may be only slightly dominant.

**Figure 5. Net Scribner board-foot volume per acre by forest type.**



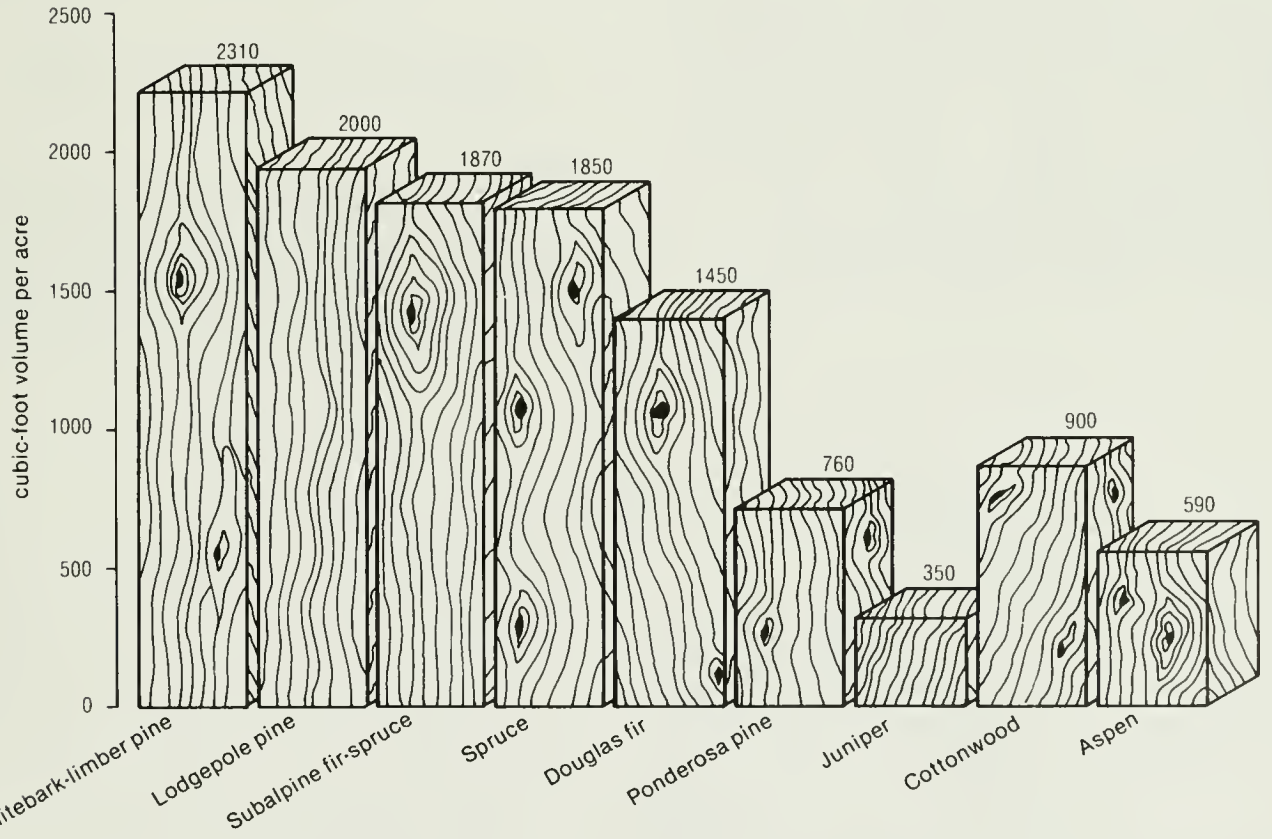
Whitebark-limber pine also had the highest average cubic-foot volume per acre followed by lodgepole pine and spruce subalpine fir forest types. (See figure 6.)

**Net Growth Per Acre**

The softwood forest type's average net growth per acre is about 21 $ft^3$/acre/year. Net growth represents the forest's average condition and age at the time of measurement. Average gross growth for softwood forest types is estimated to be 31 $ft^3$/acre/year. Mortality accounts for the difference between gross and net growth.

For a complete description of the components used to estimate growth, see the definitions for gross growth and net growth in the glossary.

**Figure 6. Net cubic-foot volume per acre by forest type.**



# ANALYSIS OF THE TIMBER RESOURCE

The approach used in this analysis is similar to the approach suggested by Green (1976). First, the available timber output is estimated, then the problems and opportunities associated with trying to achieve that potential are assessed.

## AVAILABILITY OF THE TIMBER

Every acre of state and private forest land will not be available for continuous timber harvesting. Some of the timber is not now available and probably will stay unavailable unless wood becomes much more valuable than it is now. A difficult and potentially expensive problem for any forest inventory is to answer the question of how much timber is actually available for harvesting.

The first step in assessing timber availability is to group the forest land into availability classes. This is done based on various combinations of land-use influence zones, ownership groups, and topographic characteristics. Some of the criteria used to delineate availability classes include water influence zones, travel influence zones, slope percent and elevation. These availability classes are then placed among three land classes based on each land class's definition and the characteristics of the availability class. Table 24 shows the results of this procedure.

**Table 24. Availability class definitions and components.**

| Land Class | Availability Class | Percentage of Standard Land Yield Expected | Class Definitions |
|---|---|---|---|
| **Standard** | I | 100 | Standard land definition. |
| **Special** | I | 100 | Big game winter range areas. |
| | II | 90 | Travel and municipal influence zones |
| | III | 75 | Ski resort, recreation and subdivision influence zones. |
| | IV | 50 | Water influence zones and miscellaneous private ownership group. |
| | V | 0 | Subdivided land; state administered land other than state classified forest land and state classified grazing land; Bozeman municipal watershed lands. |
| **Marginal** | VI | 50 | Slopes steeper than 60 percent and all land 8,000 feet in elevation or higher. |

### Land Classes

The commercial forest land is grouped into three land classes (Green 1976):

1) Standard: Land available and operable now and has no nontimber-use impacts that would affect the growing costs or expected yields;

2) Special: Land available and operable now, but with ecological or other use constraints that would affect the cost of growing timber, expected yield or both; and

3) Marginal: Land potentially available and operable, or both, but is not now expected to be harvested because of excessive development costs, low product returns, or resource protection constraints.

### Availability Classes

An availability class was designated for each kind of land included in each land class. Using standard land as Availability Class I where full yields can be expected to be captured, other availability classes were defined in terms of a percentage of standard land yields expected, considering impacts of other uses.

In this manner, it was possible to estimate the approximate amount of reduction in yield resulting from nontimber uses. For Working Circle 9, the reduction in yield was equivalent to reducing the forest land area by 16 percent.

Table 25 shows the amount of land in each land class.

## POTENTIAL TIMBER OUTPUT

The potential timber output curve presented in figure 7 is a reflection of what the land could produce, given certain amounts of dollars for management activities and whatever management and land-use constraints are in force.

This output curve traces the eventual production at a number of management levels, once Working

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**Table 25. Commercial forest land by land class, availability class, and productivity class, Working Circle 9 (in acres).**

| Availability Class | Productivity Class | Land Class | | | |
|---|---|---|---|---|---|
| | | Standard | Special | Marginal | Total |
| | $ft^3$/acre/year | | | | |
| I | 20-49 | 126,709 | 123,219 | 0 | 249,928 |
| | 50-84 | 27,564 | 19,733 | 0 | 47,297 |
| Total | | 154,273 | 142,952 | 0 | 297,225 |
| II | 20-49 | 0 | 99,266 | 0 | 99,266 |
| | 50-84 | 0 | 20,925 | 0 | 20,925 |
| Total | | 0 | 120,191 | 0 | 120,191 |
| III | 20-49 | 0 | 17,586 | 0 | 17,586 |
| | 50-84 | 0 | 4,145 | 0 | 4,145 |
| Total | | 0 | 21,731 | 0 | 21,731 |
| IV | 20-49 | 0 | 57,164 | 50,907 | 108,071 |
| | 50-84 | 0 | 12,796 | 13,398 | 26,194 |
| Total | | 0 | 69,960 | 64,305 | 134,265 |
| V | 20-49 | 0 | 10,159 | 0 | 10,159 |
| | 50-84 | 0 | 2,724 | 0 | 2,724 |
| Total | | 0 | 12,883 | 0 | 12,883 |
| **TOTAL** | | **154,273** | **367,717** | **64,305** | **586,295** |

Circle 9 is in a fully regulated condition. It does not define the most economically desirable budget level, which requires assigning per unit values of output (Green 1976).

**Management Levels**

Four management levels are used to produce the curve. These management levels range from doing nothing after harvest to an upper level which uses site preparation and precommercial thinning. It is assumed that if precommercial thinning were done, commercial thinning would also be undertaken.

The four management levels are:

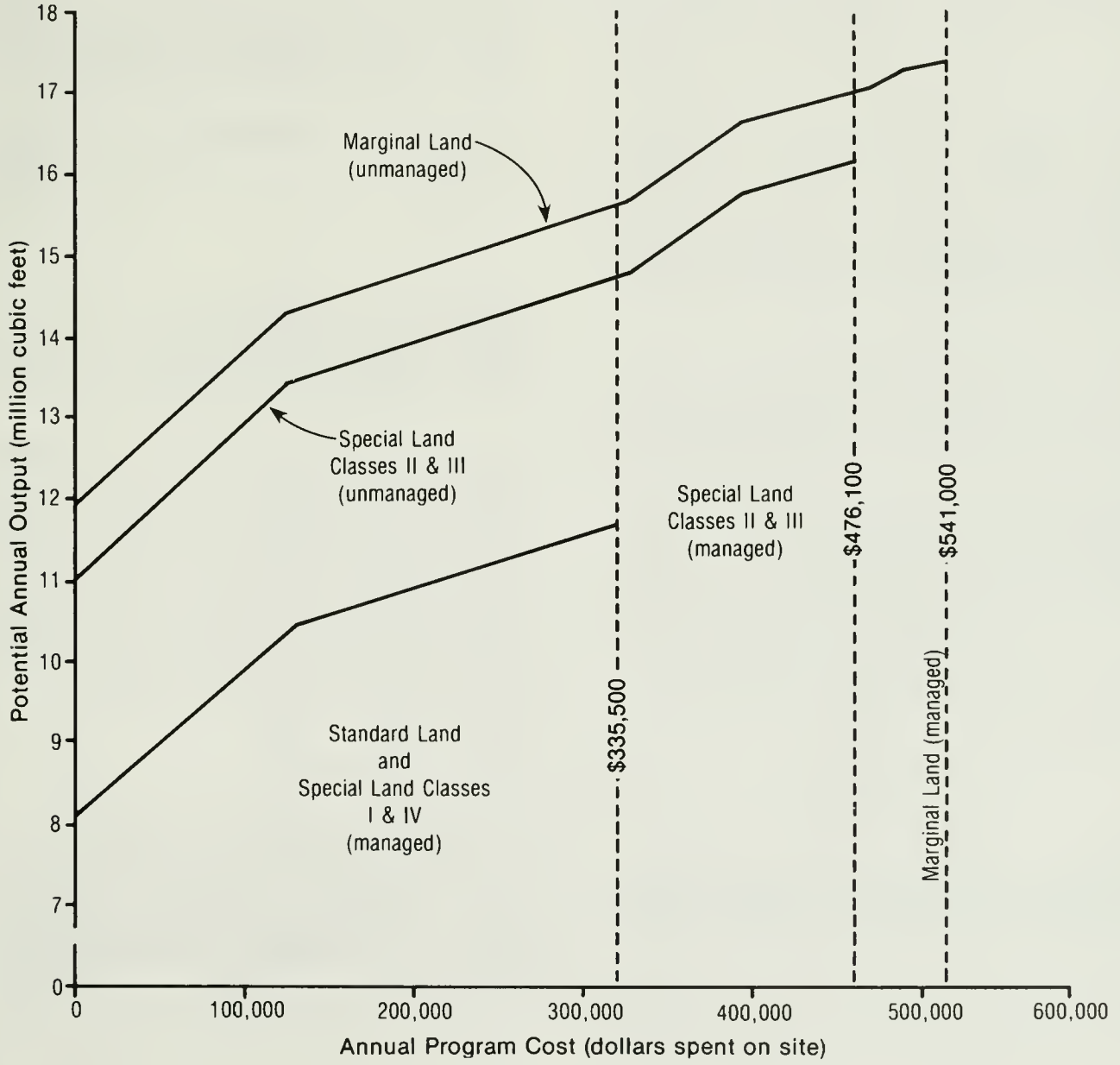
1) Management level 1, which involves no regeneration effort or stocking control;

2) Management level 2, which involves no regeneration effort but does involve stocking control;

3) Management level 3, which involves regeneration effort but not stocking control; and

4) Management level 4, which involves both regeneration effort and stocking control.

**Figure 7. Potential softwood output curve for Working Circle 9.**



Regeneration efforts in management levels 3 and 4 involve site preparation with natural regeneration in addition to normal slash disposal.

### Cost and Yield Estimates

The cost and yield estimates used to approximate the potential output curve are based on inventory data and predicted on-site treatment costs. Best estimates are used to predict increases in management costs due to steep slopes and several of the land-use influence zones. Actual cost and yield estimates used to create the curve can be found in table 70.

### The Potential Output Curve

The graph in figure 7 illustrates the annual potential timber output and an estimated on-site cost for softwood commercial forest land. The point where the curve intersects the vertical axis for the graph indicates the amount of production possible under full regulation if no treatments are conducted after harvest. As various combinations of management levels are applied, both on-site costs and yields rise. The most economically efficient timber production level is found on the graph at the point where the line bends and then proceeds at a less steep angle (10.5 million acre feet and $140,000). Beyond that output, the cost per unit increases as indicated by the flatter slope of the curve.

If all available lands are utilized for timber production, just under 12 million cubic feet of volume could be produced annually with no management cost.[1] If the most efficient combination of treatments were applied to the forest on standard and special lands, the annual yield (including unmanaged marginal lands) would be 14.7 million cubic feet, an increase of almost 2.8 million cubic feet annually at an on-site cost of $167,245 per year. Almost 17.3 million cubic feet could be produced, if all available softwood forest land were put under full management, at an on-site cost of approximately $541,000 annually.

## PHYSICAL CHARACTERISTICS OF THE FOREST

Currently the commercial forest land is producing at a level below its potential. If increasing production is desired, the existing structure and condition of the forest must be examined to determine what the problems are and to discover opportunities for improvement.

### The Potential Growth, Current Growth, and Mortality Comparison

Comparing mortality, current growth, and potential growth, one can begin to identify the problems affecting the difference between net growth and potential growth. For site class 20-49, softwood mortality amounts to 50 percent of the difference between net growth and potential growth. Net growth for these stands is 59 percent of potential. (See table 26.) For site class 50-84 net growth is only 37 percent of potential.

**Table 26. Summary of indexes* used to compare potential growth, current growth and mortality, softwood forest types only.**

| Land Productivity Class | Management Index One | Management Index Two | Mortality Index |
|---|---|---|---|
| 20-49 | .59 | .80 | .74 |
| 50-84 | .37 | .77 | .48 |

*Management index one equals net annual growth per acre divided by potential annual growth per acre.
Management index two equals gross annual growth per acre divided by potential annual growth per acre.
Mortality index equals net annual growth divided by gross annual growth.

The difference between gross growth and potential growth is 7.1 ft³/acre/year on lower site lands. For the higher site acreage, the difference is 12.6 ft³/acre/year. (See table 27.) The gap between gross growth and potential growth is a reflection of the existing condition of the forest in terms of insects, disease, age and stocking. Improving the forest condition through management would increase yield by improving growth and reducing mortality.

### A Closer Look at Mortality

Typically, the inventory method used has problems estimating mortality. But, for Working Circle 9, it is believed the amount of mortality is larger enough to allow a fairly good sample to be achieved. The estimates probably are still below the current rate of mortality, however, due to increased insect activity.

[1] Cubic-foot volumes are based on all surviving trees in the stand at harvest 1.0 inches in diameter and larger. (Brickell 1970)

**Table 27. Average cubic-foot growth and mortality per acre by softwood and hardwood forest type by productivity class, Working Circle 9 (in ft³/acre/year).**

| | SOFTWOOD FOREST TYPES | | HARDWOOD FOREST TYPES | |
|---|---|---|---|---|
| | Site Class | | | |
| | 20-49 | 50-84 | 20-49 | 50-84 |
| Net growth | 20.9 | 20.8 | 21.5 | 6.4 |
| Mortality | 7.2 | 22.6 | 10.0 | 3.7 |
| Gross growth | 28.1 | 43.4 | 31.5 | 10.1 |
| Potential growth | 35.2 | 56.0 | 32.9 | 53.0 |
| Potential growth minus gross growth | 7.1 | 12.6 | 1.4 | 42.9 |

The data shown in table 28, reveals lodgepole pine to be a major mortality contributor. Almost half of all softwood mortality is caused by dying lodgepole pine. However, this dominance seems to be restricted to stands in the 20-49 site class. For the potentially more productive stands, lodgepole pine is the largest contributor but is followed closely by subalpine fir and Douglas fir. In fact, lodgepole pine accounted for only 29 percent of the softwood losses.

**Table 28. Net annual mortality of growing stock by species and M.A.I. site class, Working Circle 9 (in thousand cubic feet).**

| Species | Site Class | | |
|---|---|---|---|
| | 20-49 | 50-84 | Total |
| Douglas fir | 975.0 | 542.2 | 1,517.2 |
| Lodgepole pine | 2,034.3 | 591.4 | 2,625.7 |
| Subalpine fir | 251.1 | 562.4 | 813.4 |
| Spruce | | 325.1 | 325.1 |
| **Total Softwoods** | **3,260.4** | **2,021.1** | **5,281.5** |
| Aspen | 209.8 | 28.3 | 238.1 |
| Cottonwood | 66.1 | 96.6 | 162.7 |
| **TOTAL All Species** | **3,536.3** | **2,146.0** | **5,682.3** |

The largest cause of death category for the softwood species is unknown (42 percent) followed by weather (33 percent). (See table 29.) The large amount of volume in the "unknown" category is an indication of the difficulty in determining what actually killed the tree. The inventory procedure allows only one damaging agent to be recorded and frequently the death of a tree is caused by two or more agents in concert or in succession.

Table 30 analyzes net volume, gross growth, and mortality by diameter class. Fifty-eight percent of softwood mortality is occurring in diameter classes 7.0 to 8.9, 9.0 to 10.9, and 11.0 to 12.9. These three diameter classes also have the highest cubic-foot volumes. There is a need to recover this mortality loss in these classes through management.

A look at the upper diameter classes reveals that trees 25 inches and larger are dying faster than they are growing. Table 30 shows gross growth to currently be 1.9 percent of total cubic-foot volume and mortality to be 0.6 percent.

In summary, the data shows mortality to be a significant loss of wood fiber that could be recovered under precommercial and intermediate treatments. The higher site class stands have a relatively much larger mortality problem than the lower site class stands. (See table 27.)

Table 28 shows that lodgepole pine and Douglas fir trees account for about 78 percent of total softwood mortality, but on higher site lands the mortality is more evenly distributed among four different species.

Insects and disease are probably the leading causes of death, although the data is inconclusive. Weather played a larger role in mortality than expected. Finally, mortality is especially high in trees from 7 to 13 inches in diameter, and trees 25 inches and larger are growing slowly enough and dying fast enough to actually reduce overall net growth.

Table 29. Annual mortality of growing stock on commercial forest land by cause of death (in cubic feet).

| Cause of Death | Douglas Fir | Lodgepole Pine | Subalpine Fir | Englemann Spruce | Total Softwoods | Aspen | Cottonwood | Total Hardwoods | All Species |
|---|---|---|---|---|---|---|---|---|---|
| Insects | 268,064 | 210,500 | 284,637 | — | 763,201 | — | — | — | 763,201 |
| Disease | 74,391 | 81,537 | — | — | 155,928 | 47,164 | — | 47,164 | 203,092 |
| Fire | 56,997 | 63,997 | — | — | 120,994 | — | — | — | 120,994 |
| Animal | — | — | — | — | — | — | — | — | — |
| Weather | 640,434 | 725,327 | 189,275 | 173,420 | 1,728,456 | — | 45,404 | 45,404 | 1,773,860 |
| Suppression | 220,850 | 90,568 | — | — | 311,418 | 28,349 | — | 28,349 | 339,767 |
| Unknown | 256,454 | 1,453,776 | 339,531 | 151,702 | 2,201,463 | 162,618 | 117,276 | 279,894 | 2,481,357 |
| Logging damage | — | — | — | — | — | — | — | — | — |
| **TOTAL** | **1,517,190** | **2,625,705** | **813,443** | **325,122** | **5,281,460** | **238,131** | **162,680** | **400,811** | **5,682,271** |

## A Closer Look at Growth

When the forest is composed of stands in many different age classes, a gap between gross growth and potential growth should be expected. Therefore, a large gap between gross growth and potential may indicate there are problems but a study of the forest's growth-related physical characteristics would be needed to assess possible improvement opportunities.

**Existing Stand Size and Age.** The area distribution by stand-size classes shows that most of the forest acreage is in stands that should be healthy and vigorous. Improvement can be made by reducing the acreage of old-growth sawtimber. Old-growth stands typically have slow growth and high mortality. Also, 3 percent of the commercial forest land area is nonstocked.

Area by stand age class, shown in table 31, indicates that 81 percent of the commercial forest stands are 120 years old or less. The dominant age class is 71 to 120 years and comprises 62 percent of the commercial acreage.

Table 30. Net volume, annual gross growth, and mortality by diameter class for softwood species, Working Circle 9 (in thousand cubic feet).

| Diameter Class (inches) | Volume | Gross Growth | Mortality |
|---|---|---|---|
| 5.0 - 6.9 | 99,552.2 | 4,266.2 | 693.3 |
| 7.0 - 8.9 | 178,517.7 | 3,303.5 | 1,146.8 |
| 9.0 - 10.9 | 178,360.3 | 3,040.3 | 820.9 |
| 11.0 - 12.9 | 139,283.1 | 2,218.0 | 1,096.2 |
| 13.0 - 14.9 | 102,008.5 | 1,672.5 | 459.4 |
| 15.0 - 16.9 | 73,561.4 | 1,045.4 | 326.1 |
| 17.0 - 18.9 | 44,659.7 | 581.9 | 126.6 |
| 19.0 - 20.9 | 29,427.5 | 326.7 | 71.3 |
| 21.0 - 22.9 | 18,884.3 | 171.6 | 92.4 |
| 23.0 - 24.9 | 12,424.6 | 93.3 | 55.6 |
| 25.0 - 26.9 | 6,121.4 | 50.6 | 56.3 |
| 27.0 - 28.9 | 3,956.1 | 25.1 | 0 |
| 29.0 + | 18,440.9 | 96.8 | 336.5 |
| **TOTAL** | **905,197.8** | **16,891.8** | **5,281.5** |

Table 31. Commercial forest land by stand age class, Working Circle 9 (in thousand acres).

| | STAND AGE CLASS | | | | | | |
|---|---|---|---|---|---|---|---|
| Forest Type | Nonstocked | 1-40 | 41-70 | 71-120 | 121-180 | 181-300+ | Total |
| Softwoods | 18.8 | 22.9 | 64.1 | 347.3 | 92.8 | 11.3 | 557.2 |
| Hardwoods | 0 | 7.7 | 14.0 | 7.3 | 0 | 0 | 29.0 |
| **TOTAL** | **18.8** | **30.6** | **78.1** | **354.6** | **92.8** | **11.3** | **586.2** |

Average breast height age by diameter class is high. (See table 64.) It is especially noticable in the lower diameter classes for high site stands and in the upper diameter classes for low site stands.

The number of pole timber and small saw log sized trees (10 to 12 inches) in the sawtimber-sized class is quite large. The first indication is the small board foot to cubic foot ratio, which for softwoods is 4.0 board feet Scribner Rule to cubic foot ratio for trees 9 inches d.b.h. and larger. The second is the low board foot per acre average. Even though 70 percent of the forest land is composed of sawtimber stands (see figure 8), only 42 percent of the area is comprised of stands that have more than 5,000 board feet of timber per acre. (See table 59.)

**Stocking.** Three main categories are used to describe the current stocking situation. They are stocking percent class, stocking component and condition class.

Table 32 shows that 127,117 acres are understocked and 66,733 acres are overstocked which means that about one-third of the commercial forest land is currently improperly stocked. Properly stocked stands are supposed to be producing at the optimum rate. Theoretically the trees are fully utilizing the site and growth per tree is not reduced by overcrowding. Two-thirds of the improperly stocked acres are understocked and producing timber below their potential.

Stocking component, analyzed in table 33, provides another view of the forest's stocking problems. Based on plot data nonstockable areas comprise a

Figure 8. Commercial forest land by stand size class, Working Circle 9.

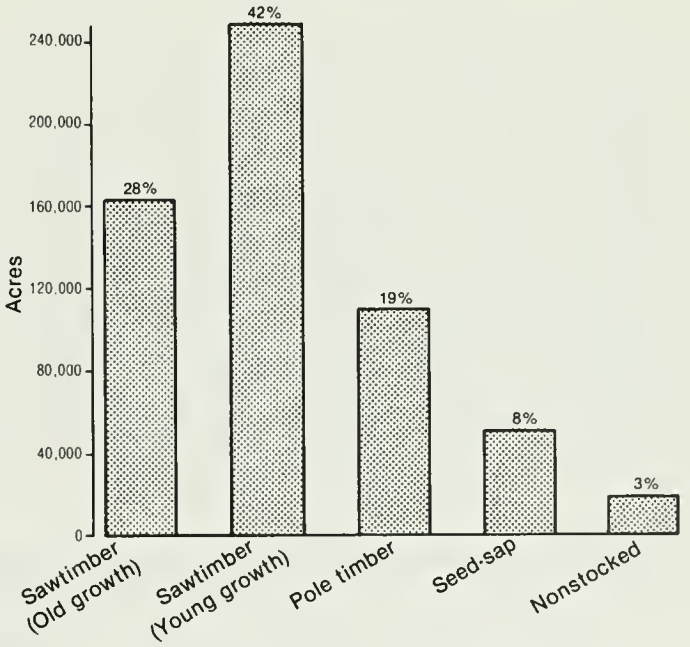



Table 32. Area of commercial forest land by stand size class and stocking percent class, Working Circle 9 (in acres).

| | Stocking Percent Class | | | |
|---|---|---|---|---|
| Stand Size Class | 59 or less (Understocked) | 60 to 132 | 133 or more (Overstocked) | Total All Classes |
| Old-growth sawtimber | 25,841 | 104,002 | 32,944 | 162,787 |
| Young-growth sawtimber | 52,222 | 182,968 | 11,485 | 246,675 |
| Pole timber | 14,820 | 71,652 | 22,304 | 108,776 |
| Seeds and saplings | 15,394 | 33,824 | 0 | 49,218 |
| Nonstocked | 18,840 | 0 | 0 | 18,840 |
| **TOTAL** | **127,117** | **392,446** | **66,733** | **586,296** |

Table 33. Area of commercial forest land by stocking component and stocking percent class, Working Circle 9 (in acres).

| Stocking Component | Stocking Percent Class | | | Total All Classes |
|---|---|---|---|---|
| | 59 or less | 60 to 132 | 133 or more | |
| Growing stock trees | 43,101 | 326,487 | 66,733 | 436,321 |
| Cull trees without juniper | 4,862 | 18,247 | 0 | 23,108 |
| Juniper cull trees | 256 | 1,900 | 0 | 2,156 |
| All live trees | 48,218 | 346,633 | 66,733 | 461,585 |
| Nonstocked, not overtopped | 47,253 | 32,926 | 0 | 80,179 |
| Nonstocked, overtopped | 2,858 | 3,777 | 0 | 6,635 |
| Inhibiting vegetation | 28,597 | 6,569 | 0 | 35,166 |
| Nonstockable | 191 | 2,540 | 0 | 2,731 |
| **TOTAL** | **127,117** | **392,446** | **66,733** | **586,296** |

small amount of acreage and should not be considered a problem. Three components that are significant problems and can be dealt with are areas occupied by cull trees, areas nonstocked and not overtopped, and areas covered by inhibiting vegetation. A total of 140,609 acres of the commercial forest land is not adequately stocked with growing stock trees and is categorized as having one of these stocking problems. Only 34 percent of the understocked area is adequately stocked with growing stock trees and 83 percent of the medium stocking class is adequately stocked by growing stock trees. There are 66,733 overstocked acres of commercial forest land.

The third category used to describe stocking is area condition class which is analyzed in table 34. Definitions for the area condition class codes can be found in the glossary under stocking.

Condition classes 60 and 90 account for 57 percent of the commercial forest acreage. Condition class 60 represents a fairly good situation where the stands are poorly stocked with desirable trees, but has medium to full stocking of growing stock trees. Condition class 90 is defined as high risk old growth stands and represents a high risk of economic loss. There are 144,398 acres of high risk old growth timber that should get immediate attention.

Table 34. Area of commercial forest land by softwood and hardwood forest type and area condition class, Working Circle 9 (in acres).

| Area Condition Class | FOREST TYPE | | Total |
|---|---|---|---|
| | Softwood Forest Type | Hardwood Forest Type | |
| 10 | 0 | 0 | 0 |
| 20 | 3,836 | 0 | 3,836 |
| 30 | 7,707 | 0 | 7,707 |
| 40 | 34,468 | 0 | 34,468 |
| 50 | 68,445 | 3,512 | 71,957 |
| 60 | 174,544 | 14,683 | 189,227 |
| 70 | 86,614 | 10,860 | 97,474 |
| 80 | 18,390 | 0 | 18,390 |
| 90 | 144,398 | 0 | 144,398 |
| Nonstocked | 18,840 | 0 | 18,840 |
| **TOTAL** | **557,242** | **29,055** | **586,297** |

**Stand Structure.** The current stand structure of the average acre of commercial forest land is shown by solid lines in figures 9 and 10. An average acre for the 20-49 productivity class has 83 square feet of basal area. Productivity class 50-84 has an average basal area of 112 square feet per acre.

If the commercial forest land base were brought under full management and were fully regulated, the forest would consist of many individual stands of different ages and tree sizes. On a per acre basis, if all these stands were combined according to site class, they would have the basal area densities distributed by diameter classes as shown in figures 9 and 10 by the solid lines. The dotted line is the average of the existing stand.

**Figure 9. Actual and desired basal area per acre by diameter class for softwood forest types for productivity class 20-49, Working Circle 9.**

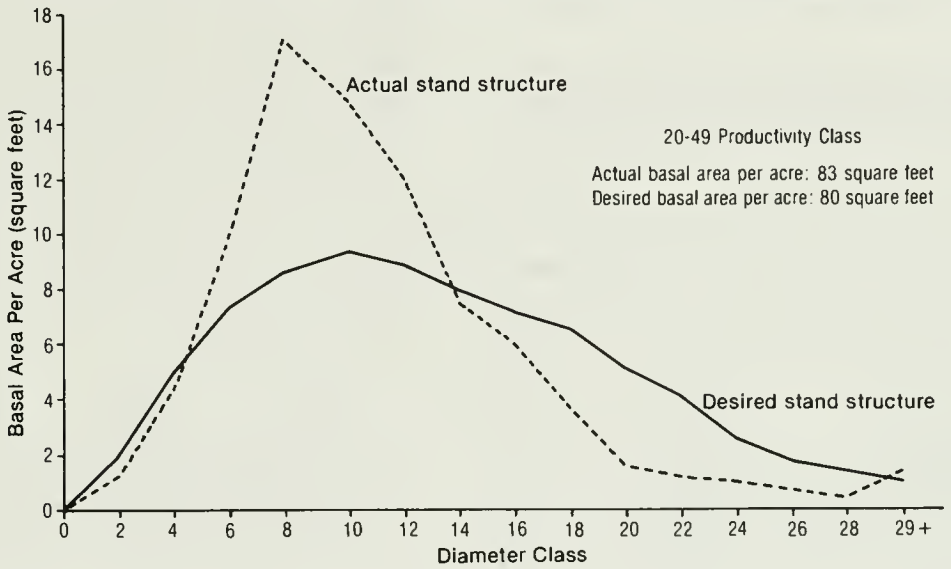
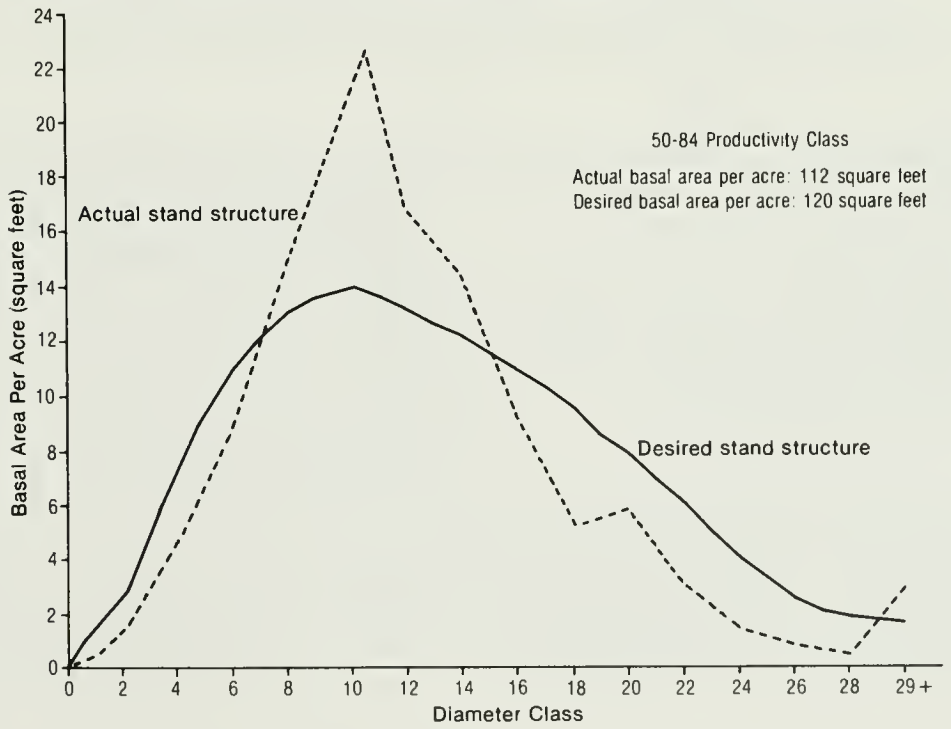

Basal Area Per Acre (square feet)
Diameter Class
Actual stand structure
Desired stand structure
20-49 Productivity Class
Actual basal area per acre: 83 square feet
Desired basal area per acre: 80 square feet

**Figure 10. Actual and desired basal area per acre by diameter class for softwood forest types for productivity class 50-84, Working Circle 9.**


Basal Area Per Acre (square feet)
Diameter Class
Actual stand structure
Desired stand structure
50-84 Productivity Class
Actual basal area per acre: 112 square feet
Desired basal area per acre: 120 square feet

The shape of the desired stand structure is based on a theoretical situation where the forest is fully regulated and a variety of round-wood materials (pulp, poles, and saw logs) are product objectives (Green 1976). The desired amount of basal area per acre stocking is an average level of stocking which should be carried over the life of the stand. Intensive management regimes would involve allowing the stand to grow to a higher basal area per acre stocking than desired and then thinning the stand back to a level below the desired stocking level, possibly repeating this process several times until final harvest. When practicing unevenaged management the stand would be harvested on a periodic cycle.

Regulating the state and private forest land on the available commercial acres would be a desirable objective for timber production. Growth and yield would increase over time as the forest approached full regulation.

The actual stand structure as compared to the desired stand structure in figures 9 and 10 indicates that the present stands are not too far from adjustment to the ideal conditions. More intensive management along with utilization of the smaller diameter materials in the 6- to 14-inch diameter class could help correct the situation. Low volumes per acre in the 14-inch and over diameter classes indicate that the sawtimber stands are below the desired level. Harvest in the 14-inch and over diameter class should be reduced and limited to high risk stands. A partial shift in harvest from the 14-inch plus sawtimber stands to the 6- to 14-inch diameter class by intermediate cuttings and commercial thinnings would be desirable to achieve the

**Table 35. Area of commercial forest land by stand size class and insect and disease category, Working Circle 9 (in acres).**

| | INSECT AND DISEASE CATEGORY | | | | | |
|---|---|---|---|---|---|---|
| Stand Size Class | Unclassified | Bark Beetle | Defoliators | Mistletoe | Rot | Total All Classes |
| Old growth sawtimber | 77,522 | 10,801 | 15,104 | 14,817 | 44,543 | 162,787 |
| Young growth sawtimber | 156,465 | 19,296 | 44,427 | 3,761 | 22,727 | 246,676 |
| Pole timber | 59,788 | 8,242 | 22,293 | 0 | 18,453 | 108,776 |
| Seedings and saplings | 41,524 | 3,871 | 0 | 0 | 3,823 | 49,218 |
| Nonstocked | 15,176 | 0 | 0 | 0 | 3,664 | 18,840 |
| **TOTAL** | **350,475** | **42,210** | **81,824** | **18,578** | **93,210** | **586,297** |

desired stocking levels in the 6- to 14-inch class and through increased growth over time would help fill the gap in the 14-inch plus diameter classes.

In the 0- to 6-inch diameter class the actual stocking is somewhat below the desired condition. Assurance of reforestation after harvest as well as reforestation of non-stocked or understocked areas would eventually correct this situation.

In summary, as utilization increases in the future, the desired stand structures would change. Trees will not be grown to the size found in old growth natural stands. Regardless of what the future holds, it is important that forests be regulated as much as possible to a desired stand structure based on utilization trends to provide an even flow of forest products.

**Insects and Disease**. Insects and disease can reduce growth. About 40 percent of the forested area is affected by insects and disease. The area of commercial forest land affected by insect or disease is analyzed in table 35. The major problem is rot which is occurring on 93,210 acres. Defoliators run a close second. Spruce budworm is the principle defoliator slowing growth in primarily Douglas fir on 81,824 acres. The bark beetle category is potentially the worst problem because most of the lodgepole pine greater than 7 inches d.b.h. (or 80 years old) growing in stands with beetle infestations will die.

The best way to reduce the effects of insects and disease is to actively pursue a program of management for thrifty young stands of mixed species.

# THE TIMBER SITUATION BY COUNTY

The three counties are nearly equal in size, but ownership patterns are quite variable, as table 36 indicates.

Note the greater percentage of private land in Meagher County as opposed to Park County where USDA Forest Service and private acreage figures are almost equal.

When looking only at nonfederal land, as in table 37, the dominance by private landowners becomes even more apparent. Park County, the largest county in total land area, has the smallest amount of nonfederal acreage, while Meagher has the most.

Figure 11 depicts the most significant differences among the counties as they appear on commercial forest land.

The substantial amount of commercial forest land owned by forest industry in Gallatin County is readily apparent. Meagher County, on the other hand, is almost entirely private where sampled commercial forests are found. The corresponding acreage figures for figure 11 are listed in table 38.

Table 39 gives the area of noncommercial forest land for the three counties. The percentage of total forested land which is noncommercial is lowest in Gallatin County at 7 percent. In both Meagher and

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**Table 36. Total land area by ownership group by county (in acres).**

| Ownership Group | COUNTY Gallatin | | Meagher | | Park | |
|---|---|---|---|---|---|---|
| | Acreage | % | Acreage | % | Acreage | % |
| **Public:** | | | | | | |
| USDI Bureau of Land Management | 14,598 | 1% | 10,625 | 1% | 13,554 | 1% |
| USDA Forest Service | 601,592 | 37 | 441,925 | 29 | 796,930 | 47 |
| State | 67,693 | 4 | 96,299 | 6 | 38,545 | 2 |
| County and municipal | 2,615 | * | —— | — | 2,739 | * |
| Subtotal | 686,768 | 42 | 548,849 | 36 | 851,768 | 50 |
| **Private:** | | | | | | |
| Forest industry | 104,741 | 7% | 2,072 | * | 43,096 | 3% |
| Other private | 821,203 | 51 | 955,575 | 63% | 788,458 | 47 |
| Subtotal | 925,944 | 58 | 957,647 | 63 | 831,554 | 50 |
| **TOTAL** | **1,612,712** | | **1,506,496** | | **1,683,322** | |

* Less than 0.5 percent

Table 37. Nonfederal land by ownership group by county (in thousand acres).

| Ownership Group | COUNTY Gallatin | | Meagher | | Park | |
|---|---|---|---|---|---|---|
| State | 68.0 | 7% | 96.3 | 9% | 38.5 | 4% |
| Forest industry | 104.7 | 11 | 2.1 | * | 43.1 | 5 |
| Private | 821.2 | 82 | 955.6 | 91 | 788.5 | 90 |
| County and municipal | 2.6 | * | 0 | 0 | 2.7 | * |
| **TOTAL** | **996.5** | | **1,053.9** | | **872.8** | |

* Less than 0.5 percent

Park counties, 13 percent of the forested land is noncommercial.

Besides being the only county with the ponderosa pine forest type, Meagher County is the county where Douglas fir is most common. This is due to the greater amounts of private land at lower elevations. The amount of private land at higher elevations in Gallatin and Park counties is reflected in the higher percentages of spruce-subalpine fir, whitebark-limber pine and spruce forest types. Table 40 indicates the amount of commercial forest land contributed by each forest type for each of the three counties.

Figure 11. Proportion of commercial forest land by ownership group for each county.

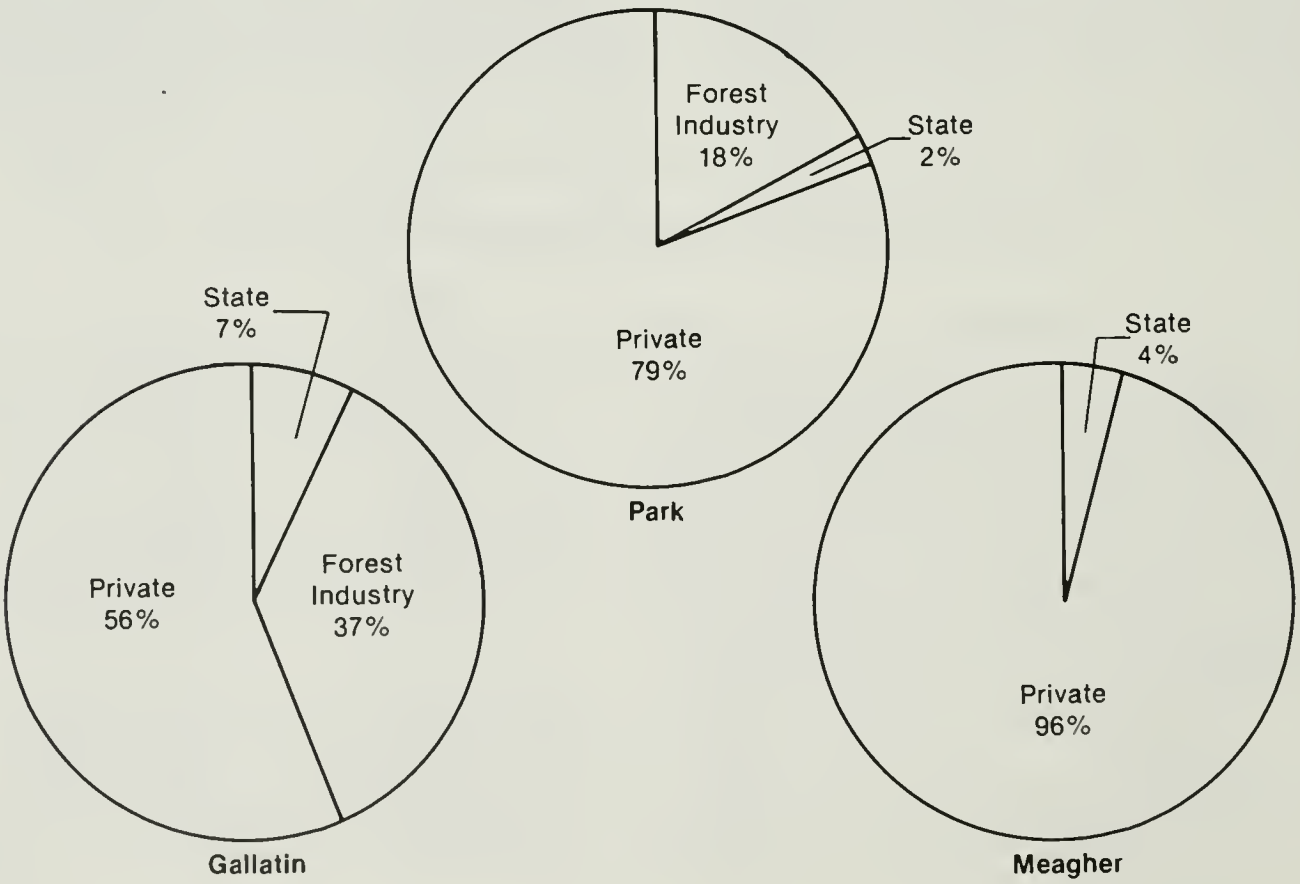

**Table 38. Commercial forest land for softwood and hardwood forest types by ownership group by county (in thousand acres).**

| Ownership Group | Softwood Forest Types | Hardwood Forest Types | Total |
|---|---|---|---|
| | **GALLATIN COUNTY** | | |
| Private and other | 122.2 | 9.0 | 131.1 |
| Industry | 83.9 | 1.6 | 85.5 |
| State | 14.8 | 1.2 | 16.0 |
| **TOTAL** | **220.9** | **11.8** | **232.7** |
| | **MEAGHER COUNTY** | | |
| Private and other | 180.4 | 7.0 | 187.4 |
| Industry | .3 | 0 | .3 |
| State | 6.8 | .5 | 7.3 |
| **TOTAL** | **187.5** | **7.5** | **195.0** |
| | **PARK COUNTY** | | |
| Private and other | 117.0 | 8.9 | 125.9 |
| Industry | 28.5 | .4 | 29.0 |
| State | 3.5 | .3 | 3.8 |
| **TOTAL** | **148.9** | **9.6** | **158.6** |

**Table 39. Area of noncommercial forest land by softwood and hardwood forest types by county (in thousand acres).**

| County | Softwood Forest Types | Hardwood Forest Types | Total |
|---|---|---|---|
| Meagher | 20.0 | 9.4 | 29.4 |
| Gallatin | 10.2 | 7.2 | 17.5 |
| Park | 14.6 | 9.5 | 24.1 |
| **TOTAL** | **44.8** | **26.1** | **71.0** |

**Table 40. Area of commercial forest land by forest type by county (in thousand acres).**

| Forest Type | Gallatin | | Meagher | | Park | |
|---|---|---|---|---|---|---|
| Douglas fir | 114.8 | 49% | 124.1 | 63% | 86.2 | 54% |
| Lodgepole pine | 52.7 | 23 | 30.0 | 15 | 30.5 | 19 |
| Ponderosa pine | 0 | 0 | 14.9 | 8 | 0 | 0 |
| Whitebark-limber pine | 12.1 | 5 | 3.9 | 2 | 9.7 | 6 |
| Spruce-subalpine fir | 26.9 | 12 | 13.3 | 7 | 16.1 | 10 |
| Spruce | 9.1 | 4 | .5 | * | 5.2 | 3 |
| Juniper | 5.3 | 2 | .7 | * | 1.3 | 1 |
| Aspen | 9.1 | 4 | 5.9 | 3 | 7.0 | 4 |
| Cottonwood | 2.7 | 1 | 1.6 | 1 | 2.7 | 2 |
| **TOTAL** | **232.7** | | **195.0** | | **158.6** | |

* Less than 0.5 percent

Table 41 analyzes commercial forest land by M.A.I. site class for the three counties. Gallatin and Park counties have the highest potential productivity with 22 percent and 20 percent respectively in the higher productivity class. Meagher County has only 9 percent in the higher class.

Gallatin County has the largest total volume in both cubic feet and board feet Scribner. Meagher County is second highest in cubic-foot volume but falls behind Park County in board-foot volume, which indicates more pole timber in Meagher County. (See tables 42 and 43.) When volume is looked at on a per acre basis, the greater occurrence of sawtimber stands in Park County becomes more evident. (See table 44.) Park County also has a greater cubic-foot volume per acre than Gallatin. (See table 45.)

The very low volumes in the hardwood forest types indicate the limited heights attained by aspen stands. (See tables 46 and 47.) Furthermore, aspen stands were often borderline between saplings and pole timber and the trees under 5.0 inches d.b.h. were not included in the cubic-foot tally.

**Table 41. Commercial forest land by M.A.I. site class for softwood and hardwood forest types by county (in thousand acres).**

| M.A.I. Site Class | Softwood Forest Types | Hardwood Forest Types | Total |
|---|---|---|---|
| | **GALLATIN COUNTY** | | |
| 20-49 | 172.2 | 8.6 | 180.8 |
| 50-84 | 48.7 | 3.2 | 51.9 |
| **All Classes** | **220.9** | **11.8** | **232.7** |
| | **MEAGHER COUNTY** | | |
| 20-49 | 172.9 | 5.0 | 177.9 |
| 50-84 | 14.6 | 2.4 | 17.1 |
| **All Classes** | **187.5** | **7.4** | **195.0** |
| | **PARK COUNTY** | | |
| 20-49 | 118.6 | 7.7 | 126.3 |
| 50-84 | 30.3 | 2.0 | 32.3 |
| **All Classes** | **148.9** | **9.8** | **158.6** |

**Table 42. Total net volume of growing stock for commercial softwood and hardwood types by county (in thousand cubic feet).**

| County | Softwood Forest Types | Hardwood Forest Types | Total |
|---|---|---|---|
| Gallatin | 358,763.3 | 3,630.4 | 362,393.7 |
| Meagher | 302,800.0 | 2,709.2 | 305,509.2 |
| Park | 258,753.9 | 3,532.7 | 262.286.6 |

**Table 43. Total net volume of sawtimber for commercial softwood and hardwood types by county (in thousand board feet).**

| | Softwood Forest Types | Hardwood Forest Types | Total |
|---|---|---|---|
| Gallatin | 1,026,347.6 | 14,976.9 | 1,041,324.5 |
| Meagher | 730,662.7 | 10,413.8 | 741,076.4 |
| Park | 745,655.1 | 12,874.5 | 758,529.6 |

**Table 44. Net volume of sawtimber per acre for commercial softwood and hardwood types by county (in board feet per acre).**

| | Softwood Forest Types | Hardwood Forest Types | Total |
|---|---|---|---|
| Gallatin | 4,647 | 1,267 | 4,475 |
| Meagher | 3,897 | 1,398 | 3,801 |
| Park | 5,009 | 1,316 | 4,781 |

**Table 45. Net volume of growing stock per acre for commercial softwood and hardwood types by county (in cubic feet per acre).**

| County | Softwood Forest Types | Hardwood Forest Types | Total |
|---|---|---|---|
| Gallatin | 1,624 | 307 | 1,557 |
| Meagher | 1,615 | 364 | 1,567 |
| Park | 1,738 | 361 | 1,653 |

**Table 46. Volume of growing stock on commercial forest land by species by county (in thousand cubic feet).**

| | Gallatin | Meagher | Park |
|---|---|---|---|
| Douglas fir | 162,401.9 | 162,239.3 | 117,927.6 |
| Ponderosa Pine | —— | 15,237.2 | —— |
| Lodgepole pine | 90,500.3 | 95,262.1 | 61,331.8 |
| Whitebark-limber pine | 31,143.5 | 4,278.4 | 25,599.2 |
| Subalpine fir | 27,148.4 | 13,855.5 | 19,856.1 |
| Englemann spruce | 40,103.3 | 9,076.5 | 28,328.2 |
| Juniper | 677.3 | 148.9 | 82.2 |
| Aspen | 7,338.4 | 3,973.6 | 6,139.9 |
| Cottonwood | 3,080.6 | 1,437.7 | 3,021.5 |
| **TOTAL** | **362,393.7** | **305,509.2** | **262,286.6** |

**Table 47. Volume of sawtimber on commercial forest land by species by county (in MBF Scribner).**

| Species | Gallatin | Meagher | Park |
|---|---|---|---|
| Douglas fir | 495,022.7 | 433,715.7 | 356,619.0 |
| Ponderosa pine | —— | 47,499.6 | —— |
| Lodgepole pine | 227,337.7 | 191,807.1 | 162,992.3 |
| Whitebark pine | 105,271.2 | 4,572.7 | 86,544.4 |
| Subalpine fir | 48,640.7 | 20,774.9 | 35,112.6 |
| Englemann spruce | 148,347.0 | 37,184.9 | 104,478.1 |
| Juniper | 924.7 | 255.8 | 11.9 |
| Aspen | 7,822.7 | 2,172.8 | 5,164.7 |
| Cottonwood | 7,957.7 | 3,092.9 | 7,606.6 |
| **TOTAL** | **1,041,324.4** | **741,076.4** | **758,529.6** |

Although Gallatin County is potentially the most productive by virtue of its overall M.A.I. site class and total acres of forest land, its timber has the lowest growth (See tables 48 and 49.) and highest mortality rates (See tables 50 and 51.) of the three counties. In the softwood forest types, cubic-foot mortality is better than half the net growth in cubic feet. Mountain pine beetle in lodgepole pine is probably the main reason for this. The growth and mortality situation is even more apparent when compared on a per acre basis as in tables 52 and 53.

**Table 48. Net growth by commercial softwood and hardwood forest types by county (in thousand cubic feet).**

| | Softwood Forest Types | Hardwood Forest Types | Total |
|---|---|---|---|
| Gallatin | 4,354.4 | 196.8 | 4,551.2 |
| Meagher | 4,047.7 | 120.8 | 4,168.4 |
| Park | 3,259.9 | 191.3 | 3,451.1 |

**Table 49. Net growth by commercial softwood and hardwood forest types by county (in MBF Scribner).**

| | Softwood Forest Types | Hardwood Forest Types | Total |
|---|---|---|---|
| Gallatin | 19,597.7 | 734.2 | 20,331.9 |
| Meagher | 19,729.2 | 466.2 | 20,195.4 |
| Park | 14,155.8 | 708.2 | 14,863.9 |

**Table 50. Net mortality by commercial softwood and hardwood forest types by county (in thousand cubic feet).**

| | Softwood Forest Types | Hardwood Forest Types | Total |
|---|---|---|---|
| Gallatin | 2,339.9 | 91.4 | 2,431.3 |
| Meagher | 1,637.3 | 59.2 | 1,696.4 |
| Park | 1,462.2 | 92.4 | 1,554.6 |

**Table 51. Net mortality by commercial softwood and hardwood forest types by county (in MBF Scribner).**

| | Softwood Forest Types | Hardwood Forest Types | Total |
|---|---|---|---|
| Gallatin | 6,610.9 | 70.5 | 6,681.4 |
| Meagher | 4,239.3 | 41.9 | 4,281.2 |
| Park | 4,285.1 | 72.0 | 4,357.1 |

**Table 52. Net growth per acre on commercial forest land by county.**

| | $ft^3$/acre | board feet Scribner/acre |
|---|---|---|
| Gallatin | 19.6 | 87.4 |
| Meagher | 21.4 | 103.6 |
| Park | 21.8 | 93.7 |

**Table 53. Net mortality per acre on commercial forest land by county.**

| | $ft^3$/acre | board feet Scribner/acre |
|---|---|---|
| Gallatin | 10.4 | 28.7 |
| Meagher | 8.7 | 22.0 |
| Park | 9.8 | 27.5 |

# CONCLUSIONS AND RECOMMENDATIONS

## OVERVIEW OF CURRENT TIMBER RESOURCE

Some of the privately owned forest lands in Working Circle 9 show the effects of a history of poor cutting practices. Many areas have residual stands consisting of inferior trees. Many young forest stands have become overstocked and need thinning. Other stands are inadequately stocked and sites are not being fully utilized.

The most immediate problem for the forest is the high mortality rate. One-third of the gross growth achieved by the forest is essentially wiped out by dying trees. Due to increased insect activity since 1976, the current mortality rate is expected to be even higher. A long term management program is needed to convert high risk stands to healthier, vigorous mixed stands to reduce the losses from insects and disease in the future.

Currently, the softwood forest's average net growth is 21 $ft^3$/acre/year and the average potential growth is estimated to be 39 $ft^3$/acre/year at culmination. Mature and overmature timber makes up the majority of the forest acreage. Many stands have low board-foot volumes with varying amounts of pole timber trees mixed among the sawtimber-sized material. See table 59. About 127,000 acres of forest land are stocked below the medium to full stocking range. Also, there are more 6- to 12-inch diameter trees than would be desired if the forest were regulated. Overall, these factors indicate a forest that is in mediocre condition when compared to an ideal situation where timber production would be higher.

## PAST HARVEST RATES AND ALLOWABLE CUT ESTIMATES

### Private and State Land Removals

Every year the DNRC Forestry Division compiles information concerning the amount of timber harvested on state and private land. This information is obtained from state land records and hazard reduction agreements made between the state and the logging operators. The volumes listed in table 54 reflect the board-foot volume loaded on the trucks and delivered to the mills. The minimum size of trees delivered is the 6-inch diameter class. In addition to the volume brought into the mills, a fair amount of volumes is left in the woods in the form of logging residue. The amount of residue left in the woods is estimated to be an additional 8 percent of the volume delivered to the mills, based on figures reported by the USDA Forest Service for Montana (Wilson et al. 1970). There are other removals occurring in Working Circle 9, but they amounted to very little volume.

The 11-year cutting history, shown in table 54 and figure 12, shows harvesting has generally been rising. The average amount harvested over the 11-year period was 33.2 million board feet. Gallatin County has been providing a little over half of the volume removed.

### Allowable Cut Estimates

An allowable cut determination is basically a planning tool used to estimate the amount of annual harvesting that can or should be implemented to achieve a management goal. The cut determinations

Table 54. Volume cut from state and private lands, calendar years 1968-78, Working Circle 9 (in board feet Scribner).

| YEAR | COUNTY | | | TOTAL |
|---|---|---|---|---|
| | Gallatin | Meagher | Park | |
| 1968 | 9,781,890 | 1,880,310 | 2,520,650 | 14,182,850 |
| 1969 | 17,315,429 | 807,680 | 1,869,560 | 19,992,669 |
| 1970 | 12,772,860 | 992,410 | 1,906,150 | 15,671,420 |
| 1971 | 22,848,860 | 648,220 | 3,006,700 | 26,503,780 |
| 1972 | 17,218,012 | 748,890 | 12,966,636 | 30,933,538 |
| 1973 | 15,092,975 | 1,918,198 | 16,668,745 | 33,679,918 |
| 1974 | 23,827,706 | 5,913,441 | 15,718,859 | 45,460,006 |
| 1975 | 20,567,928 | 6,340,206 | 7,832,728 | 34,740,862 |
| 1976 | 27,033,369 | 11,207,484 | 21,374,635 | 59,615,488 |
| 1977 | 20,608,282 | 15,496,258 | 12,524,588 | 48,629,128 |
| 1978 | 16,731,858 | 11,901,749 | 7,479,322 | 36,112,929 |
| **TOTAL** | **203,799,169** | **57,854,846** | **103,868,573** | **365,522,588** |
| **11-year average** | **18,527,197** | **5,259,531** | **9,442,597** | **33,229,326** |

made in this publication are based on one primary management goal: to provide a fairly constant flow of sawtimber volume over the length of the rotation which will eventually bring the forest into an approximately regulated condition. It should be realized that allowable cut figures are to be used as a planning tool for only 10 to 20 years. At the end of the planning period, the whole situation should be reassessed and new cut determinations calculated.

A basic assumption made to determine the cut is a 120-year rotation which contains a 110-year growing period. The 120-year rotation was selected based on a reasonable level of management on the various state and private land ownerships and the current trends in utilization in the area. This figure allows for a 10-year regeneration period. Utilizing the information provided by the availability classes, the amount of available softwood forest acreage is reduced by 16 percent. Based on the same information, existing volumes are also reduced when applicable. It is also assumed that there would be very little, if any, precommercial stocking control applied to the forest over the 120-year regulatory period.

In applying the different allowable cut formulas, various other assumptions based on inventory data are also made. These assumptions become apparent when the figures for each method of determining an allowable cut are analyzed.

**Figure 12. Volume cut from state and private lands, calendar year 1968-1978 Working Circle 9 (in MMBF Scribner)**

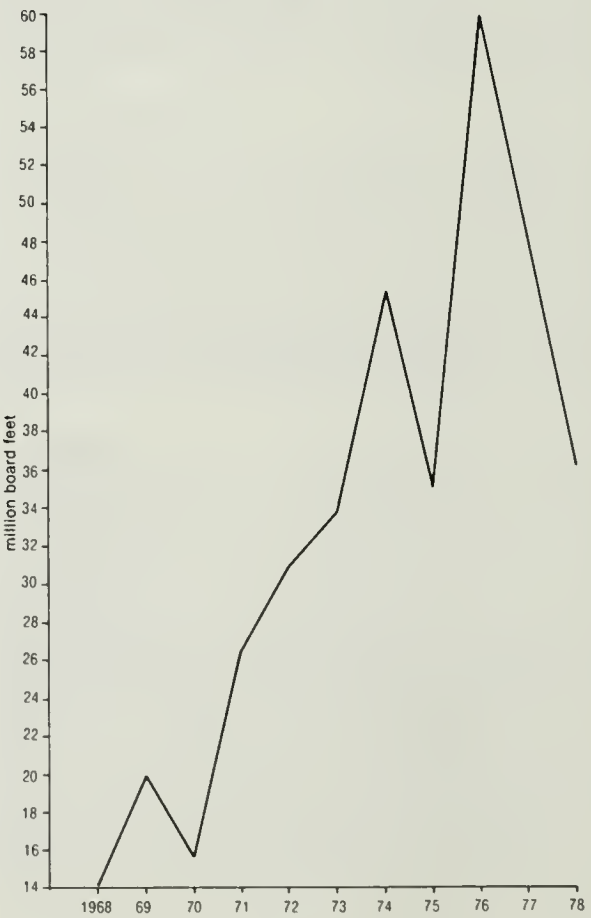

Figure 13 shows the 1976 situation, and figure 14 shows the situation 40 years later under the allowable cut harvest.

Line A in figures 13 and 14 represents the proportionate area occupied by age classes when the forest is regulated.

**Kemp's Formula.** When Kemp's formula was applied to the data, the cut was determined to be 34.1 MMBF Scribner annually. The formula and calculations are:

$$\text{Annual cut} = \frac{A_1 + 3A_2 + 5A_3 + 7A_4}{4R} \bullet Vm_a$$

Where $A_1$ = Area of unstocked and reproducing stands
$A_2$ = Area of seedling and sapling stands
$A_3$ = Area of pole timber stands
$A_4$ = Area of sawtimber stands
$Vm_a$ = Average volume per acre of sawtimber stands
$R$ = Rotation in years

$$\text{Annual cut} = \frac{15{,}769 + 3(31{,}572) + 5(79{,}287) + 7(339{,}783)}{4(120)} \bullet 5{,}672.6$$

= 34,099,428 board feet Scribner/year

**Von Mantel's Formula.** Von Mantel's formula gave an estimated annual cut of 34.5 million board feet. The formula and calculations follows:

$$\text{Annual cut} = \frac{\text{Actual available growing stock} \times 2}{\text{rotation}}$$

$$\text{Annual cut} = \frac{2{,}067{,}734{,}008 \times 2}{120}$$

= 34,462,233 board feet/year

**Stand Analysis Approach.** Applying the data to the stand analysis method, the cut is estimated to be 37.6 MMBF Scribner annually. Table 55 contains the data used to arrive at an annual cut determination.

### Comparison and Evaluation

To achieve an objective of providing a fairly constant flow of sawtimber volume over the length of the regulatory period, the indicated annual cut should average between 34 and 38 MMBF Scribner. This annual cut figure should be used as a planning guide for a 10- to 20-year period and at the end of the period, a new evaluation should be made.

Removals from the live tree inventory due to logging have averaged 33.2 MMBF Scribner over the last 11 years. When logging residue which is 8.2 percent, is added to this amount, the total volume removed comes to 35.9 MMBF Scribner annually. Since 1968,

**Figure 13. Forest situation in 1976 in relation to desired rotation, Working Circle 9.**

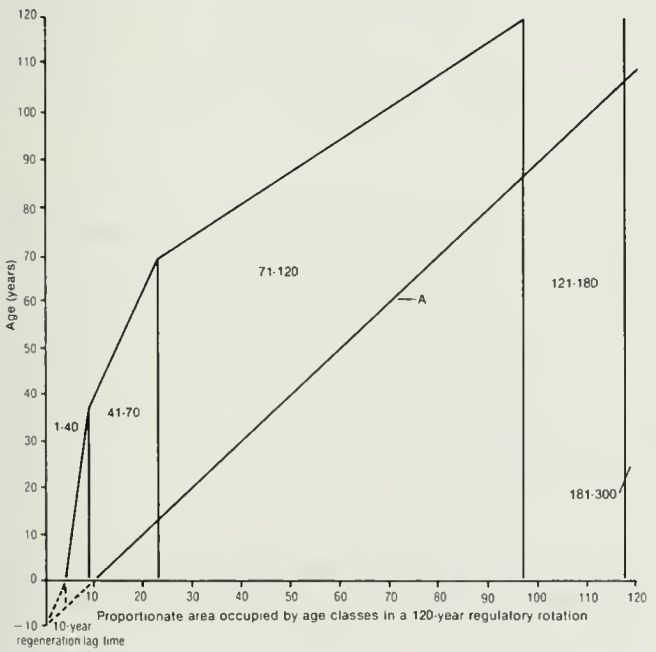


**Figure 14. Hypothetical situation after 40 years of management toward a regulated forest.**

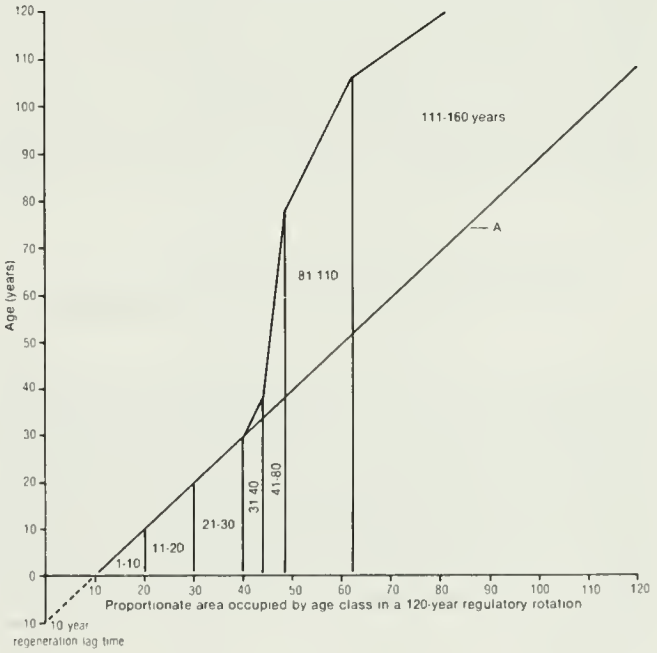

Table 55. Data used to determine an annual cut using the stand analysis method.

| Age Class | Acres | Percentage of Total Area | Total Volume (board feet Scribner) | Present Average Volume (board feet Scribner/acre) | Average Cutting Age (years) | Average Volume/Unit When Cut | Total Volume Cut (board feet Scribner) | Cutting Time Years Per Age Class | Cutting Time Years Cummulative |
|---|---|---|---|---|---|---|---|---|---|
| 181 + | 9,458 | 2.0% | 20,836,194 | 2,203 | 200 | 38,000,000 | 20,836,194 | .55 | .55 |
| 121-180 | 77,674 | 16.7 | 457,652,851 | 5,892 | 157 | 38,000,000 | 457,652,851 | 12.0 | 12.6 |
| 71-120 | 290,690 | 62.3 | 1,509,844,379 | 5,194 | 150 | 37,600,000 | 3,124,917,500 | 83.1 | 95.7 |
| 41- 70 | 53,652 | 11.5 | 88,149,743 | 1,643 | 159 | 37,300,000 | 614,315,400 | 16.5 | 112.2 |
| 1- 40 | 19,167 | 4.1 | 17,863,924 | 932 | 134 | 37,200,000 | 180,169,800 | 4.8 | 117.0 |
| Nonstocked 10-0 | 15,769 | 3.4 | 456,332 | 29 | 113 | 36,800,000 | 110,152,000 | 3.0 | 120 |
| **TOTAL** | **466,410** | **100.0%** | **2,094,962,789** | **4,492** | | | **4,508,043,745** | **120** | |

Average annual cut = $\frac{\text{Total volume cut}}{\text{rotation}}$ = 37,567,031 board feet Scribner

the amount of timber harvested on private land has steadily risen. The average volume of timber harvested since 1974 has been 44.9 MMBF Scribner annually. Adding logging residue to this figure raises the average annual volume removed to 48.6 MMBF Scribner.

In comparing the actual cut to the estimated allowable cut range, it is apparent that for the last 5 years, the cut on privately owned land has exceeded the indicated allowable cut range of 34 to 38 MMBF Scribner. This would not be a bad situation if harvest were taking place in the high risk stands. (See table 34.) However, if the indicated allowable cut were exceeded for an extended period of time, it would result in reducing the forest's growing stock, shortening the rotation and may produce a gap in supply from the private lands in the future (Davis 1976). This would cause mills to eventually cut back their production unless they could make up for the loss in supply or increased utilization. The amount of overcutting in relation to the allowable cut determines how quickly mills would experience supply problems and the severity of the supply problems.

## CAN PRODUCTION BE INCREASED?

Whether production can be increased economically is a question that is difficult to answer at this time. An active forest management program implementing regeneration efforts and stocking control would increase timber production substantially. Unfortunately, the potential productivity of the land is low and at current lumber prices in Working Circle 9, little money can be invested into intensive silvicultural treatments.

Even if it were economically feasible to implement forest management after harvesting, getting all the various landowners to actively manage their forests would still be a large problem. It is not likely that a landowner would be willing to make long term investments in forest improvements, especially when he is limited in capital. Productivity could be increased somewhat by insuring reforestation by using better harvesting practices, avoiding harvest of young timber that has not reached its growth potential, and leaving trees of good form and growth as seed trees to reforest the area.

Production could also be increased through further improved utilization. Using the latest technology in the harvesting and milling operations would result in producing more board-foot volume per tree harvested through more efficient log manufacture, smaller saw kerfs, and a more efficient first cut by the sawyer. Some mills have the capability to saw smaller diameter logs which increases production by decreasing logging residues.

Another major influence on future timber production is the individual landowner's plans concerning his forest land. Generally speaking, as forest land holdings get smaller, due to subdivisions, the owners are generally less likely to sell their timber. As more of the forest land is developed and subdivided into smaller parcels, more and more of the timber becomes unavailable. The timber land base in some areas is significantly affected by ranchers converting forest land to grazing land by logging and seeding with grass.

In summary, although it is possible that timber production could be increased, most likely it will not be increased because of current economics and landowner intent.

# APPENDIX 1
# ADDITIONAL SURVEY INFORMATION FOR WORKING CIRCLE 9

**Table 56. Summary of the area of commercial forest land by forest type, stand size, and site class, 1976 (in acres).**

| Forest Type and Stand-size Class | Site Class 50-84 | 20-49 | Total |
|---|---|---|---|
| **Douglas Fir** | | | |
| Sawtimber | 48,302 | 209,009 | 257,311 |
| Pole timber | —— | 56,591 | 56,591 |
| Sapling and seedling | —— | 7,259 | 7,259 |
| Nonstocked | —— | 3,871 | 3,871 |
| **TOTAL** | **48,302** | **276,730** | **325,032** |
| **Ponderosa Pine** | | | |
| Sawtimber | —— | 14,903 | 14,903 |
| Pole timber | —— | —— | —— |
| Sapling and seedling | —— | —— | —— |
| Nonstocked | —— | —— | —— |
| **TOTAL** | **——** | **14,903** | **14,903** |
| **Lodgepole Pine** | | | |
| Sawtimber | 11,626 | 44,767 | 56,393 |
| Pole timber | 3,744 | 30,272 | 34,016 |
| Sapling and seedling | —— | 11,667 | 11,667 |
| Nonstocked | 3,870 | 7,228 | 11,098 |
| **TOTAL** | **19,240** | **93,934** | **113,174** |
| **Whitebark-limber Pine** | | | |
| Sawtimber | 3,563 | 18,437 | 22,000 |
| Pole timber | —— | —— | —— |
| Sapling and seedling | —— | 3,665 | 3,665 |
| Nonstocked | —— | —— | —— |
| **TOTAL** | **3,563** | **22,102** | **25,665** |

| Forest Type and Stand-size Class | Site Class 50-84 | 20-49 | Total |
|---|---|---|---|
| **Spruce-Subalpine Fir** | | | |
| Sawtimber | 14,725 | 26,221 | 40,946 |
| Pole timber | 4,121 | —— | 4,121 |
| Sapling and seedling | —— | 11,205 | 11,205 |
| Nonstocked | —— | —— | —— |
| **TOTAL** | **18,846** | **37,426** | **56,272** |
| **Spruce** | | | |
| Sawtimber | 3,674 | 7,338 | 11,012 |
| Pole timber | —— | —— | —— |
| Sapling and seedling | —— | —— | —— |
| Nonstocked | —— | 3,871 | 3,871 |
| **TOTAL** | **3,674** | **11,209** | **14,883** |
| **Juniper** | | | |
| Sawtimber | —— | 3,388 | 3,388 |
| Pole timber | —— | —— | —— |
| Sapling and seedling | —— | 3,925 | 3,925 |
| Nonstocked | —— | —— | —— |
| **TOTAL** | **——** | **7,313** | **7,313** |
| **Aspen** | | | |
| Sawtimber | —— | —— | —— |
| Pole timber | —— | 10,535 | 10,535 |
| Sapling and seedling | 7,660 | 3,836 | 11,496 |
| Nonstocked | —— | —— | —— |
| **TOTAL** | **7,660** | **14,371** | **22,031** |
| **Cottonwood** | | | |
| Sawtimber | —— | 3,512 | 3,512 |
| Pole timber | —— | 3,512 | 3,512 |
| Sapling and seedling | —— | —— | —— |
| Nonstocked | —— | —— | —— |
| **TOTAL** | **——** | **7,024** | **7,024** |
| **All Types** | | | |
| Sawtimber | 81,891 | 327,574 | 409,465 |
| Pole timber | 7,865 | 100,910 | 108,775 |
| Sapling and seedling | 7,660 | 41,557 | 49,217 |
| Nonstocked | 3,870 | 14,970 | 18,840 |
| **TOTAL** | **101,286** | **485,011** | **586,297** |

**Table 57. Number of live* and salvable dead** trees by species and tree class.**

| Species | Desirable | Acceptable | Sound Cull | Rotten Cull | Salvable Dead | Total All Classes |
|---|---|---|---|---|---|---|
| Douglas fir | 20,075,313 | 40,997,229 | 11,793,452 | 367,870 | 5,029,415 | 78,263,279 |
| Ponderosa pine | 612,430 | 1,373,074 | 902,305 | 0 | 0 | 2,887,809 |
| Lodgepole pine | 12,001,937 | 24,425,483 | 8,977,154 | 133,666 | 6,097,883 | 51,636,123 |
| Whitebark pine | 481,827 | 6,925,908 | 4,666,200 | 58,035 | 405,403 | 12,537,373 |
| Subalpine fir | 14,836,353 | 9,087,821 | 8,747,046 | 228,161 | 1,244,208 | 34,143,589 |
| Engelmann spruce | 6,281,544 | 2,227,322 | 3,238,838 | 128,689 | 298,141 | 12,174,534 |
| Juniper | 2,904,989 | 1,571,610 | 1,920,861 | 92,045 | 54,817 | 6,544,322 |
| **Total softwoods** | **57,194,393** | **86,608,447** | **40,245,856** | **1,008,466** | **13,129,867** | **198,187,029** |
| Aspen | 451,952 | 3,170,650 | 2,357,989 | 249,170 | 415,876 | 6,645,637 |
| Cottonwood | 0 | 792,365 | 182,800 | 0 | 94,455 | 1,069,620 |
| **Total hardwoods** | **451,952** | **3,963,015** | **2,540,789** | **249,170** | **510,331** | **7,715,257** |
| **Total All Species** | **57,646,345** | **90,571,462** | **42,786,645** | **1,257,636** | **13,640,198** | **205,902,286** |

*1.0 + inches at d.b.h.
**5.0 + inches at d.b.h.

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**Table 58. Area of commercial forest land by net cubic-foot-per-acre stand-volume class.**

| Stand-volume Class | Area |
|---|---|
| Less than 500 ft³/acre | 105,701 acres |
| 500 to 1,499 ft³/acre | 212,211 acres |
| 1,500 to 2,499 ft³/acre | 145,504 acres |
| 2,500 to 3,499 ft³/acre | 82,166 acres |
| 3,500 to 4,999 ft³/acre | 33,623 acres |
| Over 5,000 ft³/acre | 7,091 acres |
| **TOTAL** | **586,296 acres** |

**Table 59. Area of commercial forest land by net board-foot-per-acre stand-volume class.***

| Stand-volume Class | Area |
|---|---|
| Less than 1,500 board feet/acre | 153,844 acres |
| 1,500 to 4,999 board feet/acre | 186,389 acres |
| 5,000 to 9,999 board feet/acre | 142,522 acres |
| 10,000 to 19,999 board feet/acre | 103,541 acres |
| Over 20,000 board feet/acre | 0 |
| **TOTAL** | **586,296 acres** |

*International ¼" Rule

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**Table 60. Volume, growth, and mortality by M.A.I. site class (in cubic feet).**

| | 20-49 | 50+ | Total All Classes |
|---|---|---|---|
| | | **Growing Stock** | |
| Desirable | 173,677,450 | 72,550,705 | 246,228,155 |
| Acceptable | 523,388,208 | 160,573,216 | 683,961,424 |
| **Total** | **697,065,658** | **233,123,921** | **930,189,579** |
| | | **Cull Trees** | |
| Rough | 24,596,571 | 1,683,906 | 26,280,477 |
| Rotten | 2,775,024 | 346,452 | 3,121,476 |
| **Total** | **27,371,595** | **2,030,358** | **29,401,953** |
| **TOTAL** | **724,437,253** | **235,154,279** | **959,591,532** |
| | | **Net Growth** | |
| Softwoods | 9,556,073 | 2,054,285 | 11,610,358 |
| Hardwoods | 615,838 | −55,472 | 560,366 |
| **Total** | **10,171,911** | **1,998,813** | **12,170,724** |
| | | **Mortality** | |
| Softwoods | 3,260,372 | 2,021,088 | 5,281,460 |
| Hardwoods | 275,885 | 124,926 | 400,811 |
| **Total** | **3,536,257** | **2,146,014** | **5,682,271** |
| | | **Gross Growth** | |
| Softwoods | 12,816,445 | 4,075,372 | 16,891,817 |
| Hardwoods | 891,723 | 69,455 | 961,178 |
| **Total** | **13,708,168** | **4,144,827** | **17,852,995** |

## Table 61. Annual mortality of sawtimber by species and cause of death.*

| Species | Insects | Disease | Fire | Animal | Weather | Suppression | Unknown | Logging | Total All Causes |
|---|---|---|---|---|---|---|---|---|---|
| Douglas fir | 709,798 | 91,118 | 0 | 0 | 2,398,307 | 118,198 | 972,632 | 0 | 4,290,053 |
| Ponderosa pine | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lodgepole pine | 701,652 | 218,007 | 171,041 | 0 | 1,448,272 | 0 | 5,098,026 | 0 | 7,636,998 |
| Whitebark pine | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Subalpine fir | 798,905 | 0 | 0 | 0 | 518,002 | 0 | 0 | 0 | 1,316,907 |
| Engelmann spruce | 0 | 0 | 0 | 0 | 797,897 | 0 | 687,004 | 0 | 1,484,901 |
| Juniper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total Softwoods** | **2,210,355** | **309,125** | **171,041** | **0** | **5,162,478** | **118,198** | **6,757,662** | **0** | **14,728,859** |
| Aspen | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cottonwood | 0 | 0 | 0 | 0 | 184,391 | 0 | 406,466 | 0 | 590,857 |
| **Total Hardwoods** | **0** | **0** | **0** | **0** | **184,391** | **0** | **406,466** | **0** | **590,857** |
| **TOTAL ALL SPECIES** | **2,210,355** | **309,125** | **171,041** | **0** | **5,346,869** | **118,198** | **7,164,128** | **0** | **15,319,716** |

* Net Scribner rule.

## Table 62. Net Volume of nonsalvable dead by diameter class and condition of dead (in cubic feet).

| | Firm Rotten, standing | Firm Rotten, down | Total All Classes |
|---|---|---|---|
| 5.0-6.9 inches | 1,405,635 | 1,342,389 | 2,748,024 |
| 7.0-8.9 | 1,084,162 | 1,190,576 | 2,274,738 |
| 9.0-10.9 | 1,725,481 | 696,894 | 2,422,375 |
| 11.0-12.9 | 1,353,542 | 1,002,798 | 2,356,340 |
| 13.0-14.9 | 1,129,411 | 767,746 | 1,897,157 |
| 15.0-16.9 | 750,161 | 546,135 | 1,296,296 |
| 17.0-18.9 | 573,455 | 332,968 | 906,423 |
| 19.0-20.9 | 160,991 | 170,362 | 331,353 |
| 21.0-22.9 | 386,333 | 83,935 | 470,268 |
| 23.0-24.9 | 0 | 180,583 | 180,583 |
| 25.0-26.9 | 182,349 | 197,174 | 379,523 |
| 27.0-28.9 | 77,261 | 226,163 | 303,424 |
| 29.0+ | 431,585 | 142,516 | 574,101 |
| **TOTAL** | **9,260,366** | **6,880,239** | **16,140,605** |

Table 63. Net volume of salvable dead by condition of dead class and diameter class (in cubic feet).

| | No Defect | | Defect-Mostly Physical | | Defect-Mostly Rot | | |
|---|---|---|---|---|---|---|---|
| Diameter Class | Standing | Down | Standing | Down | Standing | Down | Total |
| 5.0-6.9 inches | 1,684,836 | 0 | 6,308,850 | 796,967 | 4,117,845 | 2,168,830 | 15,077,328 |
| 7.0-8.9 | 1,880,585 | 221,567 | 4,945,616 | 1,999,804 | 4,469,637 | 2,562,869 | 16,080,078 |
| 9.0-10.9 | 380,542 | 289,614 | 4,580,237 | 987,651 | 5,385,030 | 3,340,241 | 14,963,315 |
| 11.0-12.9 | | 251,182 | 3,608,719 | 752,197 | 3,438,383 | 751,992 | 8,802,473 |
| 13.0-14.9 | 451,311 | | 1,654,378 | 1,005,341 | 1,459,028 | 803,110 | 5,373,168 |
| 15.0-16.9 | | | 1,157,477 | 313,350 | 1,681,573 | 744,097 | 3,896,497 |
| 17.0-18.9 | | | 987,154 | 162,884 | 499,592 | | 1,649,630 |
| 19.0-20.9 | | | 1,608,466 | | 561,954 | | 2,170,420 |
| 21.0-22.9 | | | 423,863 | 565,601 | 533,475 | | 1,522,939 |
| 23.0-24.9 | | | 202,663 | | 333,837 | 448,097 | 984,597 |
| 25.0-26.9 | | | | | 1,081,698 | 510,932 | 1,592,630 |
| 27.0-28.9 | | | | | | | |
| 29+ | | | | 751,166 | 885,627 | | 1,636,793 |
| **TOTAL** | **4,397,274** | **762,363** | **25,477,423** | **7,334,961** | **24,447,679** | **11,330,178** | **73,749,868** |

Table 64. Estimated average age (at d.b.h.) by diameter class and M.A.I. class.

| M.A.I. Site Class 20-49 | | | M.A.I. Site Class 50+ | | |
|---|---|---|---|---|---|
| Diameter Breast Height | Average Age at d.b.h. | Range | Diameter Breast Height | Average Age at d.b.h. | Range |
| 0.0-2.9 inches | 35 | 1-100 | 0.0-2.9 inches | 47 | 1-100 |
| 3.0-4.9 | 56 | 11-140 | 3.0-4.9 | 61 | 11-140 |
| 5.0-6.9 | 68 | 11-180 | 5.0-6.9 | 81 | 31-180 |
| 7.0-8.9 | 71 | 21-300 | 7.0-8.9 | 94 | 31-300 |
| 9.0-10.9 | 86 | 21-300 | 9.0-10.9 | 96 | 41-300 |
| 11.0-12.9 | 97 | 21-300 | 11.0-12.9 | 104 | 41-300 |
| 13.0-14.9 | 101 | 31-300 | 13.0-14.9 | 104 | 51-300 |
| 15.0-16.9 | 116 | 41-300 | 15.0-16.9 | 110 | 51-300 |
| 17.0-18.9 | 125 | 51-300 | 17.0-18.9 | 122 | 41-300 |
| 19.0-20.9 | 152 | 41-300 | 19.0-20.9 | 127 | 51-300 |
| 21.0-22.9 | 150 | 51-300 | 21.0-22.9 | 148 | 61-300 |
| 23.0-24.9 | 176 | 41-300 | 23.0-24.9 | 149 | 71-300 |
| 25.0-26.9 | 208 | 81-300 | 25.0-26.9 | 112 | 71-200 |
| 27.0-28.9 | 230 | 51-300 | 27.0-28.9 | 190 | 181-200 |
| 29+ | 249 | 51-300 | 29+ | 197 | 91-300 |

## Table 65. Area of commercial forest land by primary habitat type and local type (in acres).

| Habitat Group* | Douglas Fir | Ponderosa Pine | Lodgepole Pine | Whitebark-Limber Pine | Spruce-Subalpine Fir | Spruce | Juniper | Aspen | Cottonwood | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7,423 | 0 | 0 | 7,636 | 0 | 0 | 0 | 0 | 0 | 15,059 |
| 2 | 0 | 3,498 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3,498 |
| 3 | 0 | 3,875 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3,875 |
| 4 | 55,969 | 3,744 | 0 | 3,664 | 0 | 0 | 3,926 | 0 | 0 | 67,303 |
| 5 | 171,751 | 3,786 | 0 | 0 | 0 | 0 | 0 | 7,335 | 0 | 182,872 |
| 6 | 3,528 | 0 | 7,434 | 0 | 0 | 0 | 0 | 0 | 0 | 10,962 |
| 7 | 18,940 | 0 | 0 | 0 | 0 | 0 | 3,387 | 0 | 0 | 22,327 |
| 8 | 41,387 | 0 | 15,582 | 0 | 0 | 0 | 0 | 0 | 0 | 56,969 |
| 9 | 7,026 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7,026 |
| 10 | 7,661 | 0 | 7,055 | 0 | 0 | 0 | 0 | 0 | 0 | 14,716 |
| 11 | 3,563 | 0 | 11,388 | 0 | 0 | 7,545 | 0 | 3,836 | 0 | 26,332 |
| 12 | 4,121 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4,121 |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3,836 | 0 | 3,836 |
| 14 | 0 | 0 | 7,882 | 0 | 11,736 | 0 | 0 | 0 | 0 | 19,618 |
| 15 | 0 | 0 | 7,580 | 0 | 0 | 0 | 0 | 0 | 0 | 7,580 |
| 16 | 0 | 0 | 3,744 | 0 | 0 | 0 | 0 | 0 | 0 | 3,744 |
| 17 | 0 | 0 | 3,744 | 0 | 7,172 | 0 | 0 | 0 | 0 | 10,916 |
| 18 | 0 | 0 | 15,282 | 0 | 4,121 | 0 | 0 | 0 | 0 | 19,403 |
| 19 | 3,662 | 0 | 3,871 | 0 | 11,064 | 0 | 0 | 0 | 0 | 18,597 |
| 20 | 0 | 0 | 18,287 | 14,364 | 18,418 | 3,674 | 0 | 0 | 0 | 54,743 |
| 21 | 0 | 0 | 7,762 | 0 | 0 | 0 | 0 | 0 | 0 | 7,762 |
| 22 | 0 | 0 | 3,564 | 0 | 0 | 0 | 0 | 0 | 0 | 3,564 |
| 23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7,023 | 7,023 | 14,046 |
| 24 | 0 | 0 | 0 | 0 | 3,761 | 3,664 | 0 | 0 | 0 | 7,425 |
| **TOTAL** | **325,031** | **14,903** | **113,175** | **25,664** | **56,272** | **14,883** | **7,313** | **22,030** | **7,023** | **586,294** |

* See table 68 for habitat group definitions.

## Table 66. Volume of growing stock by primary habitat type and species (in net cubic feet).

| Habitat Group* | Douglas Fir | Ponderosa Pine | Lodgepole Pine | Whitebark Pine | Subalpine Fir | Engelmann Spruce | Juniper | Aspen | Cottonwood | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5,640,445 | 0 | 0 | 2,909,960 | 0 | 0 | 0 | 0 | 0 | 8,550,405 |
| 2 | 0 | 635,213 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 635,213 |
| 3 | 0 | 1,286,307 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,286,307 |
| 4 | 39,961,216 | 2,463,599 | 288,072 | 1,464,758 | 0 | 0 | 187,724 | 0 | 0 | 44,365,369 |
| 5 | 267,587,422 | 8,404,142 | 19,033,727 | 2,121,939 | 254,636 | 353,913 | 47,984 | 9,346,995 | 0 | 307,150,758 |
| 6 | 6,080,930 | 0 | 11,333,324 | 0 | 683,168 | 1,433,565 | 0 | 0 | 0 | 19,530,987 |
| 7 | 15,245,564 | 0 | 0 | 472,517 | 0 | 0 | 672,668 | 0 | 0 | 16,390,749 |
| 8 | 55,362,840 | 606,654 | 25,974,530 | 449,902 | 258,999 | 0 | 0 | 577,614 | 0 | 83,230,539 |
| 9 | 11,096,542 | 0 | 3,609,403 | 0 | 0 | 0 | 0 | 0 | 0 | 14,705,945 |
| 10 | 14,890,917 | 0 | 33,170,523 | 1,510,519 | 0 | 413,000 | 0 | 0 | 0 | 49,984,959 |
| 11 | 4,950,100 | 0 | 16,574,092 | 0 | 317,476 | 13,095,604 | 0 | 225,714 | 1,210,574 | 36,373,560 |
| 12 | 7,046,641 | 1,841,268 | 0 | 206,585 | 0 | 0 | 0 | 0 | 0 | 9,094,494 |
| 13 | 0 | 0 | 0 | 0 | 0 | 537,927 | 0 | 760,958 | 0 | 1,298,885 |
| 14 | 2,620,184 | 0 | 28,376,790 | 0 | 11,583,936 | 3,544,568 | 0 | 0 | 0 | 46,125,478 |
| 15 | 0 | 0 | 17,135,365 | 0 | 282,343 | 0 | 0 | 0 | 0 | 17,417,708 |
| 16 | 284,025 | 0 | 2,689,219 | 0 | 1,348,267 | 736,347 | 0 | 0 | 0 | 5,057,858 |
| 17 | 1,328,346 | 0 | 12,041,434 | 0 | 3,479,908 | 5,073,023 | 0 | 0 | 0 | 21,922,711 |
| 18 | 2,458,658 | 0 | 27,405,055 | 609,940 | 5,592,411 | 8,215,192 | 0 | 0 | 0 | 44,281,256 |
| 19 | 4,303,607 | 0 | 5,567,406 | 2,002,917 | 4,467,069 | 3,410,735 | 0 | 0 | 0 | 19,751,734 |
| 20 | 1,545,625 | 0 | 41,014,133 | 45,304,174 | 26,567,040 | 35,359,004 | 0 | 0 | 0 | 149,789,976 |
| 21 | 555,122 | 0 | 2,881,124 | 0 | 0 | 0 | 0 | 0 | 0 | 3,436,246 |
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | 279,193 | 0 | 0 | 0 | 0 | 0 | 0 | 6,540,662 | 6,329,244 | 13,149,099 |
| 24 | 1,331,425 | 0 | 0 | 3,967,921 | 6,024,844 | 5,335,155 | 0 | 0 | 0 | 16,659,345 |
| **TOTAL** | **442,568,802** | **15,237,183** | **274,094,197** | **61,021,132** | **60,860,097** | **77,508,033** | **980,376** | **17,451,943** | **7,539,818** | **930,189,581** |

* See table 68 for habitat group definitions.

## Table 67. Net annual growth of growing stock by primary habitat type and species (in net cubic feet).

| Habitat Group* | Douglas Fir | Ponderosa Pine | Lodgepole Pine | Whitebark Pine | Subalpine Fir | Englemann Spruce | Aspen | Cottonwood | Total All Species |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 41,021 | 0 | 0 | 43,227 | 0 | 0 | 0 | 0 | 84,248 |
| 2 | 0 | 8,444 | 0 | 0 | 0 | 0 | 0 | 0 | 8,444 |
| 3 | 0 | 63,811 | 0 | 0 | 0 | 0 | 0 | 0 | 63,811 |
| 4 | 793,417 | 28,684 | 6,021 | 14,646 | 0 | 0 | 0 | 0 | 842,768 |
| 5 | 4,399,760 | 166,706 | 296,275 | 29,996 | 958 | 3,698 | 188,400 | 0 | 5,085,793 |
| 6 | 188,801 | 0 | −3,923 | 0 | 4,953 | −50,014 | 0 | 0 | 139,817 |
| 7 | 265,175 | 0 | 0 | 8,590 | 0 | 0 | 0 | 0 | 273,765 |
| 8 | 851,757 | 10,426 | 471,433 | 9,601 | 1,519 | 0 | 204,244 | 0 | 1,548,980 |
| 9 | 176,665 | 0 | 36,912 | 0 | 0 | 0 | 0 | 0 | 213,577 |
| 10 | 227,649 | 0 | 163,140 | 21,158 | 0 | 7,663 | 0 | 0 | 419,610 |
| 11 | 136,574 | 0 | 324,523 | 0 | 3,521 | 178,613 | −58,340 | -69,115 | 515,776 |
| 12 | 16,711 | 14,626 | 0 | 3,260 | 0 | 0 | 0 | 0 | 34,597 |
| 13 | 0 | 0 | 0 | 0 | 0 | 11,329 | 9,495 | 0 | 20,824 |
| 14 | −42,781 | 0 | 386,896 | 0 | 165,043 | 102,159 | 0 | 0 | 611,317 |
| 15 | 0 | 0 | 368,542 | 0 | 16,730 | 0 | 0 | 0 | 385,272 |
| 16 | 2,778 | 0 | −56,506 | 0 | −49,359 | 9,326 | 0 | 0 | −93,761 |
| 17 | 14,432 | 0 | −240,948 | 0 | 46,441 | 50,122 | 0 | 0 | −129,953 |
| 18 | −95,813 | 0 | 86,056 | 3,492 | 221,842 | 115,364 | 0 | 0 | 330,941 |
| 19 | 89,356 | 0 | −612,116 | 17,769 | 76,017 | 61,066 | 0 | 0 | −367,908 |
| 20 | 11,573 | 0 | 189,553 | 691,750 | 563,034 | 319,896 | 0 | 0 | 1,775,806 |
| 21 | 11,256 | 0 | 61,205 | 0 | 0 | 0 | 0 | 0 | 72,461 |
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | 6,609 | 0 | 0 | 0 | 0 | 0 | 38,651 | 247,031 | 292,291 |
| 24 | 13,144 | 0 | 0 | 23,193 | −48,107 | 54,021 | 0 | 0 | 42,251 |
| **TOTAL** | **7,108,084** | **292,697** | **1,477,063** | **866,682** | **1,002,592** | **863,243** | **382,450** | **177,916** | **12,170,727** |

* See table 68 for habitat group definitions.

* See table 68 for habitat group definitions.

**Table 68. Habitat type group definitions for tables 65, 66, and 67.**

| Group | Definition |
|---|---|
| 1 | *Pinus flexilis* climax series |
| 2 | *Pinus ponderosa/Agropyron spicatum* h.t.; *Pinus ponderosa/Festuca idahoensis* h.t. |
| 3 | *Pinus ponderosa/Symphoricarpos albus* h.t. |
| 4 | *Pseudotsuga menziesii/Agropyron spicatum* h.t./*Pseudotsuga menziesii/Festuca idahoensis* h.t. |
| 5 | *Pseudotsuga menziesii/Physocarpus malvaceus* h.t.; *Pseudotsuga menziesii/Symphoricarpos albus* h.t., *Symphoricarpos albus* and *Calamagrostis rubescens* phases |
| 6 | *Pseudotsuga menziesii/Vaccinium globulare* h.t.; *Pseudotsuga menziesii/Linnaea boarealis* h.t. |
| 7 | *Pseudotsuga menziesii/Symphoricarpos albus* h.t., *Agropyron spicatum* phase |
| 8 | *Pseudotsuga menziesii/Calamagrostis rubescens* h.t., *Calamagrostis rubescens* phase; *Pseudotsuga menziesii/Carex geyeri* h.t. |
| 9 | *Pseudotsuga menziesii/Spiraea betulifolia* h.t. |
| 10 | *Pseudotsuga menziesii/Juniperus communis* h.t.; *Pseudotsuga menziesii/Arnica cordifolia* h.t. |
| 11 | *Picea/Physocarpus malvaceus* h.t.; *Picea/Galium triflorum* h.t.; *Picea/Linnaea borealis* h.t.; *Picea/Smilacina stellata* h.t. |
| 12 | *Pseudotsuga menziesii* climax series |
| 13 | *Picea/Equisetum arvense* h.t. |
| 14 | *Abies lasiocarpa/Galium triflorum* h.t.; *Abies lasiocarpa/Linnaea borealis* h.t. |
| 15 | *Abies lasiocarpa/Vaccinium caespitosum* h.t. |
| 16 | *Abies lasiocarpa/Calamagrostis canadensis* h.t. |
| 17 | *Abies lasiocarpa/Vaccinium globulare* h.t. |
| 18 | *Abies lasiocarpa/Vaccinium scoparium* h.t. |
| 19 | *Abies lasiocarpa/Calamagrostis rubescens* h.t. |
| 20 | *Abies lasiocarpa/Luzula hitchcockii* h.t.; *Abies lasiocarpa-Pinus albicaulis/Vaccinium scoparium* h.t. |
| 21 | *Pinus contorta* climax series |
| 22 | *Picea climax* series |
| 23 | Hardwood climax series |
| 24 | Scree |

## Table 69. Area of commercial forest land by local type and fuel model* (in acres).

| | FUEL MODEL | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Timber Type** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **Total All Models** |
| Douglas fir | 33,743 | 7,325 | 194,577 | | 4,121 | 36,956 | 37,373 | 10,936 | | 325,031 |
| Ponderosa pine | 7,373 | | 7,530 | | | | | | | 14,903 |
| Lodgepole pine | 3,664 | 3,926 | 18,634 | 3,926 | 4,121 | 22,409 | 37,602 | 15,328 | 3,563 | 113,173 |
| Whitebark-limber pine | 3,875 | | 11,099 | | | 7,127 | 3,563 | | | 25,664 |
| Spruce-subalpine fir | | 3,674 | 15,124 | | | 3,744 | 25,739 | 4,121 | 3,871 | 56,273 |
| Spruce | 3,871 | | | | 3,674 | | 7,338 | | | 14,883 |
| Pinyon-Juniper | 3,926 | | 3,387 | | | | | | | 7,313 |
| Aspen | 3,836 | | 3,823 | | | 3,836 | | 10,535 | | 22,030 |
| Cottonwood | 3,512 | | | | | | | 3,512 | | 7,024 |
| **Total All Types** | **63,800** | **14,925** | **254,174** | **3,926** | **11,916** | **74,072** | **111,615** | **44,432** | **7,434** | **586,294** |

*Fuel models were adopted from "Aids to Selecting Fuel Model for Estimating Fire Behavior" by Hal E. Anderson, in preparation for publication, INT.

Fuel Model 1:
The primary fire carrier is a continuous bed of fine fuels.[4] Examples: western grasslands, open stands of pinyon¢juniper and desert shrubs.

Fuel Model 2:
Chaparral or other dense brush; recently partially cut or thinned conifer stands where slash is a serious fuel problem. Examples: mature California and some other southwest chaparral.

Fuel Model 3:
The primary fire carrier is grass or other herbaceous plants. Examples: young conifer plantations where trees occupy less than 2/3 of the area; open ponderosa pine, and timber-sagebrush-grass associations. Pinyon-juniper stands included where a continuous ground fuel develops most years and where pinyon makes up more than 1/3 of the stand.

Fuel Model 4:
Heavy amounts of fuels 1 inch or less in diameter and little or no material greater than 2 inches in diameter. Examples: sagebrush, conifer plantations, and other situations where woody plants occupy 2/3 or more of area. Also covers chaparral situations not dense enough or heavy enough to qualify for Model 2.

Fuel Model 5:
Constructed primarily for the oak-hickory type but also covers **closed** stands of conifers with needles 2 inches or more in length (most pines). **Short needled conifers are better covered by Model 8.**

Fuel Model 6:
Fairly continuous cover of young brush or shrub species with little or no dead material; foliage does not burn readily. Types: mountain mahogany, manzanita. Grass and other herbaceous plants may be present, **but if ground fuels form a continuous cover, use Fuel Model 1.**

Fuel Model 7:
This primarily applies to dense conifer stands with heavily accumulation or downed tree material from natural breakup of overmature stands, insect and disease damage, wind or ice storms, thinnings or partial cuts. Canopies are usually closed but large openings are common. Types covered include windthrown or bug-killed LPP and S; also thinned or partially cut conifer stands with heavy settled slash.

Fuel Model 8:
Includes most closed short-needled conifer types and hardwoods, when in leaf or after compaction of leaf litter by rain or snow. **Pine and pine-hardwood associations** (pines 1/3 or more of overstory) **and dormant hardwoods are best covered by Model 5.**

Fuel Model 9:
Applies to clearcut conifer areas. Fuel loadings highest of all fuel models, but are mid-range for most such areas in the West. **In ponderosa and other pines of similar growth characteristics, use Model 4.**

[4] Fine fuels: the complex of living and dead herbaceous plants and dead woody plant materials less than ¼ inch in diameter.

## Table 70. Basic management costs and excepted yields for softwoods, Working Circle 9.

| Productivity Class | Average Productivity | Available Area | Management Level | Regeneration Period | Growing Period | Rotation | YIELD EXPECTED | | MANAGEMENT COSTS PER ACRE | | | PRODUCTION COSTS | | Management Cost Per Year | Yield Expected Per Year | Cost Per Thousand Cubic Feet |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Per Acre Total | Per Acre Per Year | | Activities | | Per Unit Yield | Annual Per Acre | | | |
| ft³/acre/year | | Acres | | Year | | | Cubic Feet | | A | B | Total | | | $ | Cubic Feet | $ |
| **Availability Class I—Standard Land** | | | | | | | | | | | | | | | | |
| 20-49 | 35 | 123,787 | 1 | 20 | 120 | 140 | 3,192 | 22.8 | 0 | 0 | 0 | .000 | .00 | .00 | 2,822,343 | .00 |
| | | | 2 | 20 | 120 | 140 | 4,249 | 30.4 | 0 | 60 | 60 | .014 | .43 | 53,015.57 | 3,757,819 | 14.12 |
| | | | 3 | 5 | 120 | 125 | 3,191 | 25.5 | 71 | 0 | 71 | .022 | .57 | 79,311.01 | 3,161,024 | 22.24 |
| | | | 4 | 5 | 120 | 125 | 4,250 | 34.0 | 71 | 60 | 131 | .031 | 1.05 | 129,728.77 | 4,208,758 | 30.82 |
| 50-84 | 56 | 22,701 | 1 | 15 | 110 | 125 | 5,016 | 40.1 | 0 | 0 | 0 | .000 | .00 | .00 | 910,945 | .00 |
| | | | 2 | 15 | 110 | 125 | 6,209 | 49.7 | 0 | 60 | 60 | .010 | .48 | 10,896.48 | 1,127,785 | 9.66 |
| | | | 3 | 5 | 110 | 115 | 5,015 | 43.6 | 71 | 0 | 71 | .014 | .62 | 14,015.40 | 990,158 | 14.15 |
| | | | 4 | 5 | 110 | 115 | 6,210 | 54.0 | 71 | 60 | 131 | .021 | 1.14 | 25,859.40 | 1,225,854 | 21.10 |
| **Availability Class I—Special Land** | | | | | | | | | | | | | | | | |
| 20-49 | 35 | 120,182 | 1 | 20 | 120 | 140 | 3,192 | 22.8 | 0 | 0 | 0 | .000 | .00 | .00 | 2,740,149 | .00 |
| | | | 2 | 20 | 120 | 140 | 4,249 | 30.4 | 0 | 60 | 60 | .014 | .43 | 51,506.57 | 3,648,382 | 14.12 |
| | | | 3 | 5 | 120 | 125 | 3,191 | 25.5 | 71 | 0 | 71 | .022 | .57 | 68,263.37 | 3,068,967 | 22.24 |
| | | | 4 | 5 | 120 | 125 | 4,250 | 34.0 | 71 | 60 | 131 | .031 | 1.05 | 125,950.73 | 4,068,188 | 30.82 |
| 50-84 | 56 | 19,044 | 1 | 15 | 110 | 125 | 5,106 | 40.1 | 0 | 0 | 0 | .000 | .00 | .00 | 764,197 | .00 |
| | | | 2 | 15 | 110 | 125 | 6,209 | 49.7 | 0 | 60 | 60 | .010 | .48 | 9,141.12 | 946,105 | 9.66 |
| | | | 3 | 5 | 110 | 115 | 5,015 | 43.6 | 71 | 0 | 71 | .014 | .62 | 11,757.60 | 830,649 | 14.15 |
| | | | 4 | 5 | 110 | 115 | 6,210 | 54.0 | 71 | 60 | 131 | .021 | 1.14 | 21,693.60 | 1,028,376 | 21.10 |
| **Availability Class II—Special Land** | | | | | | | | | | | | | | | | |
| 20-49 | 35 | 85,116 | 1 | 20 | 120 | 140 | 3,192 | 22.8 | 0 | 0 | 0 | .000 | .00 | .00 | 1,940,644 | .00 |
| | | | 2 | 20 | 120 | 140 | 4,249 | 30.4 | 0 | 75 | 75 | .018 | .54 | 45,597.86 | 2,583,878 | 17.65 |
| | | | 3 | 5 | 120 | 125 | 3,191 | 25.5 | 71 | 0 | 71 | .022 | .57 | 48,345.89 | 2,173,522 | 22.24 |
| | | | 4 | 5 | 120 | 125 | 4,250 | 34.0 | 71 | 75 | 146 | .034 | 1.17 | 99,415.49 | 2,893,944 | 34.35 |
| 50-84 | 56 | 17,936 | 1 | 15 | 110 | 125 | 5,016 | 40.1 | 0 | 0 | 0 | .000 | .00 | .00 | 719,735 | .00 |
| | | | 2 | 15 | 110 | 125 | 6,209 | 49.7 | 0 | 75 | 75 | .012 | .60 | 10,761 00 | 891,060 | 12.08 |
| | | | 3 | 5 | 110 | 115 | 5,015 | 43.6 | 71 | 0 | 71 | .014 | .62 | 11,073.53 | 782,321 | 14.15 |
| | | | 4 | 5 | 110 | 115 | 6,210 | 54.0 | 71 | 75 | 146 | .024 | 1.27 | 22,770.92 | 968,544 | 23.51 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Availability Class III—Special Land** | | | | | | | | | | | | | | | | |
| 20-49 | 35 | 12,659 | 1 | 20 | 120 | 140 | 3,192 | 22.8 | 0 | 0 | 0 | .000 | .00 | .00 | 288,625 | .00 |
| | | | 2 | 20 | 120 | 140 | 4,249 | 30.4 | 0 | 75 | 75 | .018 | .54 | 6,781.61 | 384,291 | 17.65 |
| | | | 3 | 5 | 120 | 125 | 3,191 | 25.5 | 71 | 0 | 71 | .022 | .57 | 7,190.31 | 323,260 | 22.24 |
| | | | 4 | 5 | 120 | 125 | 4,250 | 34.0 | 71 | 75 | 146 | .034 | 1.17 | 14,785.71 | 430,406 | 34.35 |
| 50-84 | 56 | 2,872 | 1 | 15 | 110 | 125 | 5,106 | 40.1 | 0 | 0 | 0 | .000 | .00 | .00 | 115,247 | .00 |
| | | | 2 | 15 | 110 | 125 | 6,209 | 49.7 | 0 | 75 | 75 | .012 | .60 | 1,723.20 | 142,680 | 12.08 |
| | | | 3 | 5 | 110 | 115 | 5,015 | 43.6 | 71 | 0 | 71 | .104 | .62 | 1,773.15 | 125,269 | 14.15 |
| | | | 4 | 5 | 110 | 115 | 6,210 | 54.0 | 71 | 75 | 146 | .024 | 1.27 | 3,646.19 | 155,088 | 23.51 |
| **Availability Class IV—Special Land** | | | | | | | | | | | | | | | | |
| 20-49 | 35 | 24,051 | 1 | 20 | 120 | 140 | 3,192 | 22.8 | 0 | 0 | 0 | .00 | .00 | .00 | 548,362 | .00 |
| | | | 2 | 20 | 120 | 140 | 4,249 | 30.4 | 0 | 60 | 60 | .014 | .43 | 10,307.57 | 730,119 | 14.12 |
| | | | 3 | 5 | 120 | 125 | 3,191 | 25.5 | 71 | 0 | 71 | .022 | .57 | 13,660.97 | 614,166 | 22.24 |
| | | | 4 | 5 | 120 | 125 | 4,250 | 34.0 | 71 | 60 | 131 | .031 | 1.05 | 25,205.45 | 817,734 | 30.82 |
| 50-84 | 56 | 6,185 | 1 | 15 | 110 | 125 | 5,016 | 40.1 | 0 | 0 | 0 | .000 | .00 | .00 | 248,191 | .00 |
| | | | 2 | 15 | 110 | 125 | 6,209 | 49.7 | 0 | 60 | 60 | .010 | .48 | 2,968.80 | 307,270 | 9.66 |
| | | | 3 | 5 | 110 | 115 | 5,015 | 43.6 | 71 | 0 | 71 | .014 | .62 | 3,818.57 | 269,773 | 14.15 |
| | | | 4 | 5 | 110 | 115 | 6,210 | 54.0 | 71 | 60 | 131 | .021 | 1.14 | 7,045.52 | 333,990 | 21.10 |
| **Availability Class IV—Marginal Land** | | | | | | | | | | | | | | | | |
| 20-49 | 35 | 25,315 | 1 | 20 | 120 | 140 | 3,192 | 22.8 | 0 | 0 | 0 | .000 | .00 | .00 | 577,181 | .00 |
| | | | 2 | 20 | 120 | 140 | 4,249 | 30.4 | 0 | 108 | 108 | .025 | .77 | 19,528.71 | 768,491 | 25.41 |
| | | | 3 | 5 | 120 | 125 | 3,191 | 25.5 | 142 | 0 | 142 | .045 | 1.14 | 28,757.84 | 646,443 | 44.49 |
| | | | 4 | 5 | 120 | 125 | 4,250 | 34.0 | 142 | 108 | 250 | .059 | 2.00 | 50,630.00 | 860,710 | 58.82 |
| 50-84 | 56 | 6,561 | 1 | 15 | 110 | 125 | 5,016 | 40.1 | 0 | 0 | 0 | .000 | .00 | .00 | 263,279 | .00 |
| | | | 2 | 15 | 110 | 125 | 6,209 | 49.7 | 0 | 108 | 108 | 017 | .86 | 5,668.70 | 325,950 | 17.39 |
| | | | 3 | 5 | 110 | 115 | 5,015 | 43.6 | 142 | 0 | 142 | .028 | 1.23 | 8,101.41 | 286,173 | 28.31 |
| | | | 4 | 5 | 110 | 115 | 6,210 | 54.0 | 142 | 108 | 250 | .040 | 2.17 | 14,263.04 | 354,294 | 40.26 |

Total Available Acreage = 466,409 acres
*Cost figures based on 1979 dollars.

**Table 71. Ratio of net board-foot-Scribner volume to net cubic-foot volume by local type and diameter class.**

| Diameter Class | Douglas Fir | Lodgepole Pine | Total All Softwood |
|---|---|---|---|
| 9.0-10.9 | 2.5 | 3.4 | 2.9 |
| 11.0-12.9 | 3.5 | 4.8 | 4.0 |
| 13.0-14.9 | 4.1 | 4.9 | 4.4 |
| 15.0-16.9 | 4.4 | 4.9 | 4.5 |
| 17.0-18.9 | 4.6 | 4.8 | 4.6 |
| 19.0-20.9 | 4.8 | 4.8 | 4.7 |
| 21.0-22.9 | 5.0 | 4.9 | 4.9 |
| 23.0-24.9 | 5.0 | | 4.9 |
| 25.0-26.9 | 5.0 | | 5.0 |
| 27.0-28.9 | 5.1 | | 5.1 |
| 30+ | 5.1 | | 5.1 |
| **Total sawtimber (all trees 10'' + diameter breast height)** | **3.8** | **4.2** | **4.0** |
| **Total growing stock (all trees 6'' + diameter breast height)** | **2.9** | **2.4** | **2.8** |

**Table 72. Total area and available area of softwood forest land by availability class (in acres).**

| | Total Area | Available Area |
|---|---|---|
| Availability class I—standard land | 146,488 | 146,488 |
| Availability class I—special land | 139,226 | 139,226 |
| Availability class II—special land | 114,502 | 103,052 |
| Availability class III—special land | 20,708 | 15,531 |
| Availability class IV—special land | 60,472 | 30,236 |
| Availability class IV—marginal land | 63,752 | 31,876 |
| Availability class V—special land | 12,094 | 0 |
| | 557,242 | 466,409 |

# APPENDIX 2. WOOD PROCESSORS IN WORKING CIRCLE 9

**Table 73. Wood-processing mills in Working Circle 9.***

| Company | Annual Production | Species Processed | Products Manufactured |
|---|---|---|---|
| **GALLATIN COUNTY** | | | |
| Yellowstone Pine | D | | |
| Arley Adams | A | | Portable sawmill |
| Lumber Enterprises | A | DF, LPP | Lbr., studs, houselogs |
| Dave Wolney | A | DF, LPP | Lbr., dim, rough |
| Siga Lumber | A | DF, ES, LPP | Lbr., timbers, rough |
| Herk's West Yellowstone Lumber Co. | A | LPP, DF | Lbr., dim, rough |
| **MEAGHER COUNTY** | | | |
| Castle Mountain Co. | D | DF, ES, LPP, PP | Dim, lbr., timbers, rough and surfaced |
| **PARK COUNTY** | | | |
| Brand S Lumber | C | DF, ES, LPP | Dim, lbr., studs, surfaced |
| Burkland Studs | C | LPP | Studs |
| Willow Creek Lumber Co. | B | LPP, ES | Dim, timbers, rough and surfaced |
| Dale Merril | A | | |
| Jacob Bliler | A | | Part-time |
| Ralph Myrstol Sawmill | A | | Portable sawmill |
| Dale Menvey | A | | Portable sawmill |
| Gene Wade | A | | Portable sawmill |
| Double A Lumber | A | | |
| Park Lumber Co. | A | DF, LPP, ES | Dim, lbr., timbers, rough and surfaced |
| Art Davis Sawmill | A | | Part-time sawmill |
| Edd Hardin Sawmill | A | | Part-time sawmill |

* See table 74 for the key to this table's codes.

## Table 74. Key to table 73.

**Annual Production**

A — Less than 3,000 MBF
B — 3,000-5,000 MBF
C — 5,000-10,000 MBF
D — 10,000-25,000 MBF
E — 25,000-50,000 MBF
F — Greater than 50,000 MBF

**Species Processed**

DF — Douglas fir
ES — Englemann spruce
PP — Ponderosa pine
LPP — Lodgepole pine

**Products**

Dim. — Dimension
Lbr. — 1'' Boards
ties — crossties
timbers
studs
houselogs
rough
surfaced

# APPENDIX 3
# FIELD DATA FORMS

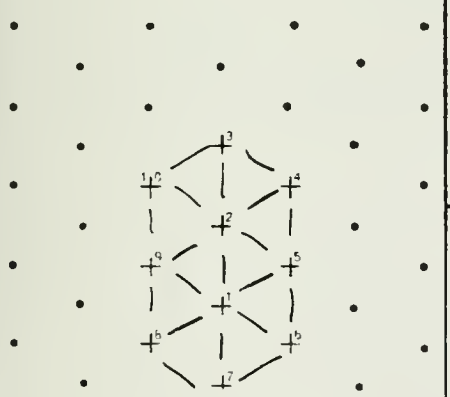
**LOCATION RECORD SHEET** — STATE 30 — COUNTY 031 — LOCATION 005

LOCATION DESCRIPTION | AREA CLASSIFICATION | AREA DESCRIPTION | OPTIONS

| X | SURVEY UNIT | REGION NATIONAL FOREST | WORKING CIRCLE | UTM NORTH SOUTH COORDINATES | UTM EAST WEST COORDINATES | SAMPLE KIND | DATE OF SURVEY | ELEVATION | PI LAND USE | GROUND LAND USE | USF TREND | OWNER | STAND ORIGIN | ASPECT / SLOPE PHYSIO CLASS | STAND CLASSIFICATION | SEED SOURCE | FOREST TYPE | SLOPE POSITION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 10 | 11 | 12 13 14 | 15 16 | 17 18 19 20 21 22 | 23 24 25 26 27 28 | 29 | 30 31 32 33 | 34 35 36 | 37 38 | 39 40 | 41 42 | 43 44 | 45 | 46 47 48 | 49 50 | 51 | 52 53 | 54 55 56 57 58 59 60 61 62 63 64 |
| - | 12 | — | 09 | 1506563 | 0305072 | R | 0987 | 06 | 12 | R0 | + | 40 | 1 | 751 | 01 | 1 | | R! |

## LOCATION INFORMATION

**TEN POINT LAYOUT**




**REFERENCE POINT**

SP 202

DBH 7.5

RP is 20' tall Doug. fir 50' E. of ridge top, with trees of similar size both above and below. Base of RP tree leans downhill. Location is across ridge top

**GENERAL STATEMENT**

From Main & Rouse in Bozeman, drive N. on Bridger Canyon Rd. 10.0 mi., turn left on rd. going thru aspen patchy drive 1.0 mi. Walk up ridge to crest. Walk N. along ridge top about 200' to RP

Fuel model C

**COURSE TO SAMPLE LOCATION**

AZ 223 DIST. 150

**WITNESS TREES**

X—SP 202 DBH 7.0 AZ 314 DIST. 28.1

Y—SP 202 DBH 6.2 AZ 339 DIST. 15.2

**FIELD CREW**

ESTIMATOR Metzmaker

RECORDER Remington

**PHOTOS**

PROJECT F63 ROLL 22

PHOTO NOS 151, 152

**FIELD EDIT**

NAME D. Remington

DATE 8-16-76

**OFFICE EDIT**

NAME Wallace

DATE Aug. 23, 1976

DECLINATION 0° B.A.F. 40

| 1S | 7E | 18 |
|---|---|---|
| TOWNSHIP | RANGE | SECTION |

# TREE DATA SHEET

| STATE | 1 | 2 | COUNTY | 3 | 4 | 5 | LOCATION | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | 0 | | | | | | | | |

| TREE IDENTIFICATION | | | | | | | | | | TREE MEASUREMENT | | | | TREE CLASSIFICATION | | | | | | | | OPTIONS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| POINT NUMBER | | TREE NUMBER | | AZIMUTH | | DISTANCE | TREE HISTORY | SITE TREE CODE | SPECIES | D B H | | HEIGHT | | 10 YEAR RAD GROWTH | TREE AGE | CR RATIO | CR CLASS | REL. CROWN CANOPY POSITION | SURFACE DEFECT | INT DEFECT | TOT VOL LOSS | DAMAGE/ CAUSE OF DEATH | TREE/ COVER CLASS | HABITAT TYPE | Mistletoe | Dead Cond. J. Stems | | |
| 9 | 10 | 11 | 12 | 13 14 15 | | 16 | 17 | 18 | 19 | 20 | 21 | 22 23 24 | | 25 26 27 | 28 29 30 | 31 | 32 | 33 34 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 45 | 46 47 | 48 49 50 | 51 | 52 53 54 55 56 57 58 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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RITE IN THE RAIN PAPER

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# GLOSSARY

**Acceptable tree**
Growing-stock tree of commercial species that does not qualify as a desirable tree.

**Accretion**
Annual increase in net volume of trees in a size class, and the increase in net volume of trees after reaching a measured size class during the year.

**Allowable cut**
The volume of timber that would be cut on commercial forest land during a given period under specified management plans for sustained production such as those in effect on national forests.

**Area condition class**
A classification of commercial forest land based upon stocking by desirable trees and other conditions affecting current and prospective timber growth.

**Basal area**
A measure of square feet of space occupied by the stem of a tree. This measurement is made at breast height.

**Basal area factor**
The basal or stem area per unit of stand area for a given angle for each tree intercepted from a given point.

**Bureau of Land Management lands**
Federal land administered by the USDI Bureau of Land Management.

**Census water**
Water areas of more than 40 acres and water courses more than 1/8 mile wide.

**Commercial forest land**
Forest land producing or capable of producing crops of industrial wood and not withdrawn from timber utilization. (Note: Areas qualifying as productive forest land have the capability of producing in excess of 20 $ft^3$/acre/year of industrial wood under management. Currently inaccessible and inoperable areas are included, except where the areas involved are small and unlikely to become suitable for production of industrial wood in the foreseeable future.)

**Crown class**
A classification of trees based on dominance in relation to adjacent trees in the stand as indicated by crown development and amount of light received from above and the sides.

**Cull**
Portions of a tree that are unusable for industrial wood products because of rot, form, or other defect.

**Diameter breast height (d.b.h.)**
The diameter of a tree at a point 4½ feet above the ground on the tree's uphill side. Height of d.b.h. may vary on abnormally formed trees.

**Desirable tree**
Live noncull trees of commercial species are divided into two classes: desirable and acceptable. For a tree to be desirable it must be free from disease, of good form, potentially not more than 10 percent defect of disease or fire scar, of good vigor, and not excessively limby if sawtimber. A tree will be considered to have good vigor if it has 40 percent or more crown (exception: ponderosa pine, and aspen may have only 30 percent crown to be classed as desirable). It is the kind of tree that would be favored in cultural operations or featured in management in under rotation-age stands. Mature trees (over rotation age) of commercial size with less than 20 percent defect and expected to live 10 years are low-risk trees and may also be classed as desirable trees. A species which is not adapted to the site should be classified as sound cull.

**Diameter classes**
A classification of trees based on diameter outside bark, measured at breast height (4½ feet above the ground). (Note: D.b.h. is the common abbreviation for diameter at breast height. Two-inch diameter classes are commonly used in Forest Survey, with the even inch the approximate midpoint for a class. For example, the 6-inch class includes trees 5.0 through 6.9 inches d.b.h., inclusive.)

**Farmer-rancher lands**
Lands owned by individuals with a minimum of 40 acres.

**Fixed radius plot**
For this inventory a 1/300 acre (6.8 feet radius), circular plot, located at each sample point on which live trees up to 4.99 inches d.b.h. are tallied.

**Forest land**
Land at least 16.7 percent stocked by forest trees, or formerly having such tree cover, and not currently developed for nonforest use. Forest land does not include land currently developed for nonforest uses such as urban or thickly settled residential or resort areas, city parks, orchards, improved roads, or pasture lands improved by such measures as seeding or irrigation. The minimum area for classification of forest land is one acre. Roadside, streamside, and shelterbelt strips of timber must be at least 120 feet wide to qualify as forest land. Unimproved roads, trails, streams, and clearings in forest areas are classed as forest land if they are less than 120 feet wide.

**Forest types**
A classification of forest land based upon the dominant species forming a plurality of stocking based on area occupied in the present tree cover.

**Forest industry**
Lands owned by companies or individuals operating wood-using plants.

**Fish, Wildlife, and Park land**
Land administered by the Montana Department of Fish, Wildlife, and Parks.

**Gross growth**
Annual increase in net volume of trees in the absence of cutting and mortality. It includes ingrowth and accretion.

**Growing-stock trees**
Sawtimber trees, pole timber trees, saplings, and seedlings that is, all live trees except cull trees.

**Habitat type**
An aggregation of all land areas potentially capable of producing similar plant communities at climax.

**Hardwoods**
Dicotyledonous trees, usually broad-leaved and deciduous.

**Ingrowth**
The number or net volume of trees that grow large enough during a specified year to qualify as saplings, pole timber, or sawtimber. The measurement is at the size of entry into the size class.

**Land use influence zones**
Zones delineated around areas or regions where it is likely that other nontimber uses or environmental constraints would have an impact on availability of timber.

**Mean annual increment**
A measure of the volume of wood, in cubic feet, produced on 1 acre during 1 year. Forest Survey minimum standard for commercial forest land is the ability to produce 20 $ft^3$/acre/year.

**Miscellaneous federal**
Federal lands other than national forest lands, lands administered by the USDI Bureau of Land Management, or Indian lands.

**Mortality**
Number of sound-wood volume of growing stock trees dying from natural causes during a specified period.

**Mortality tree**
A tree of commercial species, 5.0 inches d.b.h., or larger standing or down, that has died within the past 5 years and was not a cull tree at the time of death.

**National forest land**
Federal lands which have been designated by executive order or statute as national forests or purchase units and other lands under the administration of the USDA Forest Service, including experimental areas.

**Net annual growth**
The increase in net volume of a specified size class for a specific year. (Note: Components of net annual growth include the increment in net volume of trees at the beginning of the specific year surviving to its end, plus net volume of trees reaching the size class during the year, minus the net volume of trees that died during the year, minus the net volume of trees that became rough or rotten trees during the year.) Net growth figures in this publication when expressed as $ft^3$/acre/year of growing stock are for all live growing stock trees 5.0 inches d.b.h. and larger.

**Net volume**
The gross volume of a tree less deductions for rot, sweep, or other defect affecting use for wood products.

**Noncommercial forest land**
Unproductive forest land incapable of yielding crops of wood because of adverse site conditions and productive forest land withdrawn from commercial timber use through statute or administrative regulations.

**Noncommercial species**
Tree species of typically small size, poor form, or inferior quality which normally do not develop into trees suitable for industrial wood products.

**Nonforest land**
Land that has never supported forests and lands formerly forested where use for timber management is precluded by development for other uses. It includes areas used for crops, improved pasture, residential areas, city parks, improved roads of any width and adjoining clearings, powerline clearings of any width and 1 to 40 acres of water classified by the Bureau of the Census as land. If intermingled in forest areas, unimproved roads and nonforest strips must be more than 120 feet wide, and clearings, etc., more than 1 acre in size to qualify as nonforest land.

**Nonsalvable dead**
Dead trees 5.0 inches d.b.h. and larger, standing and down, and less than 50 percent sound on a cubic-foot basis.

**Firm rotten** Tree is less than 50 percent sound on a cubic-foot basis. More than half the total volume loss is due to rot and less than half is due to such defects as excessive sweep and crook. Tree or potential product sections are firm enough to hold together if handled.

**Crumbly rotten** Tree is less than 50 percent sound on a cubic-foot basis. More than half the total volume loss is due to rot and less than half is due to such defects as excessive sweep and crook. Tree or potential product sections will not hold together if handled.

**Nonstockable**
Areas of forest land not capable of supporting seedlings of commercial species because of the presence of rock, water, roads, etc.

**Nonstocked land**
Commercial forest land less than 16.7 percent stocked with growing stock trees.

**Old-growth sawtimber stands**
Sawtimber stands in which 50 percent or more of the area is occupied by old-growth sawtimber trees.

**Old-growth sawtimber trees**
Trees that are at least 100 years old.

**Other private corporate**
Land owned by corporations not in the forest industry.

**Other private individual**
Lands smaller than 40 acres owned by individuals.

**Other state lands**
State land other than state forests, land board, and Fish, Wildlife, and Parks.

**Potential growth**
Or yield capability is defined as mean annual increment of growing stock attainable in fully stocked natural stands at the age of culmination of mean annual increment. When expressed in cubic feet of growing stock, unless specified otherwise, the volume figure includes all surviving live trees 1.0 inches d.b.h. and larger, for most tree species. See Brickell (1970) for further information.

**Pole timber stands**
Stands at least 16.7 percent stocked with growing stock trees of which 50 percent or more of this stocking is in pole timber and/or sawtimber trees, and with pole timber stocking exceeding that of sawtimber.

**Pole timber trees**
Trees at least 5.0 inches in diameter at breast height but smaller than 9.0 inches for softwoods and 11.0 inches for hardwoods.

**Productive-reserved forest land**
Forest land sufficiently productive to qualify as commercial forest land, but withdrawn from timber utilization through statute, administrative designation, or exclusive use for Christmas-tree production.

**Rotation**
The period of years between establishment of a stand of timber and the time when it is considered ready for cutting and regeneration.

**Rotten trees**
Live trees of commercial species that do not contain at least one 12-foot saw log or two noncontiguous saw logs, each 8 feet long or longer, now or prospectively, and/or do not meet regional specifications for freedom from defect primarily because of rot; that is, when more than 50 percent of the cull volume in a tree is rotten.

**Rough trees**
(1) Live trees of commercial species that do not contain at least one 12-foot saw log or two noncontiguous saw logs, each 8 feet long or longer, now or prospectively, and/or do not meet regional specifications for freedom from defect primarily because of roughness or poor form.

(2) all live trees of noncommercial species.

**Salvable dead**
Standing and down dead trees 5.0 inches d.b.h. and larger and more than 50 percent sound on a cubic foot basis.

**No defect** Tree has no rot, and no defect such as excessive sweep and crook.

**Defect-mostly physical** Tree is more than 50 percent sound on a cubic-foot basis. Less than half the total volume loss is due to rot and more than half is due to such defects as excessive sweep and crook.

**Defect-mostly rot** Tree is more than 50 percent sound on a cubic-foot basis. More than half the total volume loss is due to rot and less than half is due to such defects as excessive sweep and crook. Tree or potential product sections are firm enough to hold together if handled.

**Saplings**
Trees 1.0 inches to 4.0 inches in diameter at breast height.

**Saw log**
A section of a tree stem of sufficient size to yield commercial size dimension lumber.

**Sawtimber stands**
Stands at least 16.7 percent stocked with growing stock trees, with half or more of total stocking in sawtimber or pole timber trees, and with sawtimber stocking at least equal to pole timber stocking.

**Sawtimber trees**
Softwood trees which are 9.0 inches and larger and hardwood trees which are 11.0 inches and larger in diameter at breast height.

**Scribner Rule**
The common board-foot log rule used in determining volume of sawtimber in the Western states.

**Seedlings**
Live trees less than 1.0 inch in diameter at breast height.

**Site class**
A classification of forest land in terms of inherent capacity to grow crops of industrial wood. Site classifications are based upon the mean annual growth of growing stock (not including thinnings) attainable in fully stocked stands at culmination of mean annual growth. Height-age relationships are usually used as indicators of the specified volume-site class.

**Site index class**
A measure of site productivity based upon the height of trees at a given base age. Site index classes are height classes represented by a graphed curve of height over age for each class.

**Softwoods**
Coniferous trees, usually evergreen, having needle or scale-like leaves.

**Stand density**
A quantitative measure of a stand in terms of square feet of basal area, number of trees, or volume per acre. It reflects the degree of crowding of stems within the area.

**Stand-size class**
A classification of forest land based on the class of growing stock trees on the area, that is,

sawtimber, pole timber, or seedlings and saplings. (Note: Only those trees that contribute to no more than 16 per cent of stocking at a plot point, based upon a 10-point location, will be considered in determining stand-size class.)

**State forest land**
State owned land that is principally valuable for forest and watershed cover that is classified as forst and administered by the Department of Natural Resources and Conservation, Forestry Division.

**State forest**
Lands managed cooperatively by the DNRC Forestry Division and the State Land board.

**State grazing land**
State owned land that is principally valuable for forage production that is classified as grazing and administered by the Department of State Lands.

**Stocking**
Stocking is an effort to express the extent to which growing space is effectively utilized by present or potential growing-stock trees or commercial species. "Percent of stocking" is synonymous with "percentage of growing space occupied" and means the ration of actual stocking to full stocking for comparable sites and stands. Basal area is used as a basis for measuring stocking.

"Stocking percentages" express current area occupancy in relation to specified standards for full stocking based on number, size, and spacing of trees considered necessary to fully utilize the forest land.

Full utilization of the site is assumed to occur over a range of basal area. As an interim guide, 60 percent of the normal yield table values has been used to establish the lower limit of this range which represents full site occupancy. This is called 100-percent stocking. The upper limit of full stocking has been set at 133 percent. Sites with less than 100-percent stocking represent understocking with less than full site occupancy. Over-stocking is characterized by sites that have over 133 percent stocking.

Class 10—Areas fully stocked with desirable trees and not overstocked.

Class 20—Areas fully stocked with desirable trees, but overstocked with all live trees.

Class 30—Areas medium to fully stocked with desirable trees and with less than 30 percent of the area controlled by other trees and/or inhibiting vegetation or surface conditions that will prevent occupancy by desirable trees.

Class 40—Areas medium to fully stocked with desirable trees and with 30 percent or more of the area controlled by other trees and/or conditions that ordinarily prevent occupancy by desirable trees.

Class 50—Areas poorly stocked with desirable trees, but fully stocked with growing stock trees.

Class 60—Areas poorly stocked with desirable trees, but with medium to full stocking of growing stock trees.

Class 70—Areas nonstocked or poorly stocked with desirable trees, and poorly stocked with growing stock trees.

Class 80—(West only) Low-risk old-growth stands.

Class 90—(West only) High-risk old-growth stands.

Class 99—Nonstocked.

**Tree class**
A classification assigned to each live tree based on such physical characteristics as surface and internal defects, relative pole length, crown ratio and position, and damage sustained by the tree. (See also desirable tree, acceptable tree, rough tree, and rotten tree.)

**Tree size class**
A classification of trees primarily according to diameter at breast height outside bark, including sawtimber trees, pole timber trees, saplings, and seedlings.

**Unproductive forest land**

Forest land incapable of producing 20 cubic feet per acre of industrial wood under natural conditions, because of adverse site conditions. (Note: Adverse conditions include sterile soils, dry climate, poor drainage, high elevation, steepness, and rockiness.)

**Variable radius plot**

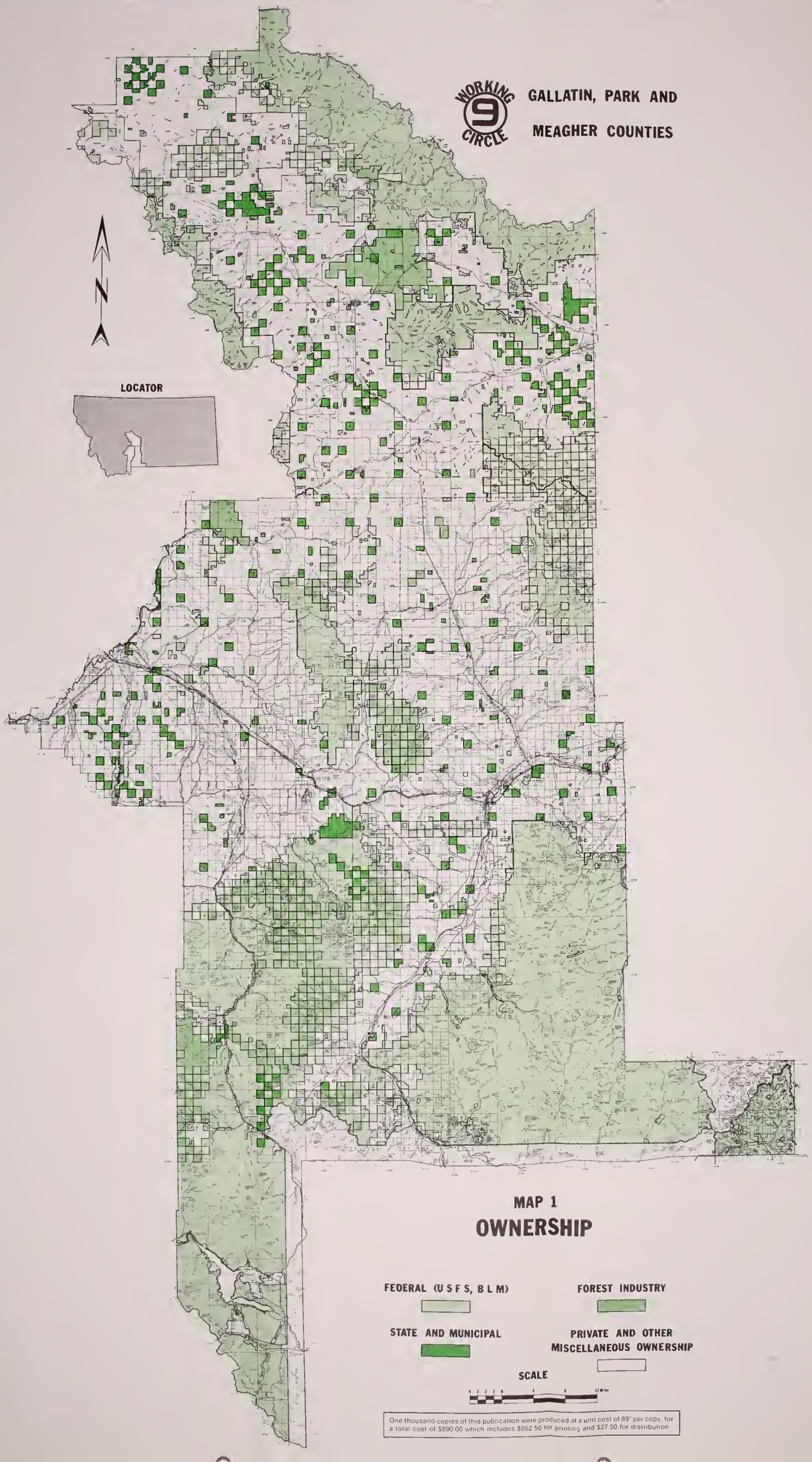
A plot on which a predetermined critical angle is projected from a central point, and swept in a full circle, to determine the basal area, tree count, and volume per unit of area. The radius of this plot is a function of tree basal area and is therefore variable.

**Young-growth sawtimber stands**

Sawtimber stands in which 50 percent or more of the stand is occupied by young-growth sawtimber trees.

**Young-growth sawtimber trees**

Sawtimber trees less than 100 years old.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